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OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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COMING MEETINGS OF THE SOCIETY

January 14, *New York City*, Engineering Societies Building. Business meeting, followed by topical discussion on subject to be announced. Informal dinner, 6.15 p.m. Meet in Society's rooms.

January 22, *Boston, Mass.*, Joint meeting with Boston Society of Civil Engineers and Boston Section of American Institute of Electrical Engineers. Paper: New Water Supply System for New York City, J. Waldo Smith, chief engineer.

May 20–23, *Baltimore, Md.*, Spring Meeting. Headquarters, Hotel Belvedere.

June 21–*July* 7, Joint Meeting with Verein deutscher Ingenieure, Leipzig and various industrial cities of Germany. See page 4 for further details.

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THE SPRING MEETING

The members may look forward with anticipation to the coming Spring Meeting, to be held in Baltimore, May 20-23. This will be the first visit of the Society to this city and the cordiality of the invitation received from the members resident there, as well as the Engineers Club and the civic organizations, is evidenced by the fact that it was extended two years in advance of the date for the meeting.

The technical sessions have already been tentatively determined by the Committee on Meetings, and at a meeting of the Baltimore members, the Engineers Club and the civic organizations, held in Baltimore on December 19 and attended by the Secretary, the general scheme of social features was discussed. The Chairman of the Local Committee will be Layton F. Smith, past-president of the Baltimore Engineers Club.

Baltimore with its remarkable harbor and its nearness to Washington and Annapolis is a most attractive city in which to hold a convention, and the membership are assured of adequate and comfortable accommodations at the Hotel Belvedere, the headquarters selected. More than three hundred rooms are available and the hotel is most conveniently arranged in respect to meeting halls, accessibility, etc. As the date of the meeting comes within the height of the season in Baltimore, when the weather

is ideal and the city is crowded with visitors, hotel accommodations should be reserved in advance and as early as possible, in order to insure against disappointment.

One of the excursions which will be included in the program laid out by the local committee will be a trip to Annapolis, one of the oldest cities in America, and hence of historical as well as pariotic interest. The trip will probably be made by boat, and the visitors will have an opportunity to see the grounds and buildings, on which fifteen million dollars have recently been expended, and to watch the midshipmen in various naval manoeuvres.

There will also be excursions to the hydroelectric plant at McCalls Ferry on the Susquehanna River, and to the various points of interest in Baltimore itself, such as the new sewerage disposal plant recently installed at an expense of twenty million dollars, the new system of municipal docks, as well as its principal industries, including sealing devices, canning and preserving, and tobacco.

MEETING IN GERMANY

Advice has been received from the Verein deutscher Ingenieure that since the meeting in Leipzig will occur during the summer vacation season when hotel accommodations will be strained to the utmost and because of the difficulty of conducting large groups through industrial establishments, the party which is to participate in the Leipzig meeting next summer must be limited to 200 members and 100 ladies. It is possible, however, that all who go may find accommodations. So far 176 members have signified their intention of attending the meeting.

The party will sail on June 10 on the Hamburg-American liner Victoria-Luise, arriving in Hamburg on Saturday, June 21. This vessel will accommodate 500 passengers, and the anticipation is that members and their friends will make up the entire passenger list. Through the courtesy of the steamship company, a discount of 5 per cent is being allowed on all bookings, provided such discount does not bring the net amount below the minimum; and in addition a discount of 20 per cent will be made on all who return by the Hamburg-American line before August 1, under similar conditions as regards minimum price. The total cost of the

trip through Germany is estimated at $87 per adult, based upon a minimum number of 300.

The estimated cost of the entire trip is as follows:

New York to Hamburg, via Victoria-Luise	$97.50	(minimum)
Official trip through Germany	87.00	
Munich to Hamburg, 2d class ticket	10.90	
Return trip to New York (estimated)	95.00	(minimum)
	$290.40	

Applications will be registered in the order of their receipt at the headquarters of the Society. When the prescribed limit has been reached, any vacancies which may occur in the party will be filled in the order of receipt of subsequent requests.

The program as announced includes many features of interest. Upon arrival in Hamburg, the party will be formally received by the municipal authorities and will proceed by special train to Leipzig either the same or the following day. A visit will also be paid to the great shipyards in Hamburg. There will an informal gathering of the members of the party on Sunday evening, June 22, and on Monday morning, June 23, the meeting will formally open. The King of Saxony is expected to welcome the visitors and there will be two addresses, one by a representative of the German society and the other of the American organization, on some general subject, such as the history of engineering, the relation of capital and labor, and the effect on industry of technical education. Tuesday, the last day to be spent in Leipzig, will be devoted to technical papers and to various social events and participation in the patriotic gathering in commemoration of the one-hundredth anniversary of the battle of Leipzig.

The party will leave on Wednesday for a tour of industrial Germany, visiting the principal cities, and including a trip up the Rhine from Bonn to Rüdesheim. Independence Day will be celebrated at Frankfurt am Main under the auspices of the American embassy.

The final meeting will be held in Munich, July 7, in connection with the Museum of Technical Arts, of which Dr. von Miller is director.

CURRENT AFFAIRS OF THE SOCIETY

Following the suggestion made by Dr. Alex. C. Humphreys in his presidential address delivered at the Annual Meeting in New York, the Council has authorized the placing of the name of Alex. L. Holley to precede the list of past-presidents of the Society, with the title of chairman of the organization meeting. Mr. Holley may rightfully be regarded as a past officer and numbered among those who have done much to serve the Society.

CODE ETHICS

The attention of the membership is drawn to the report of the Code of Ethics Committee, appearing elsewhere in this issue. This preliminary code has been drafted by the committee with a view to promoting discussion from the membership, so that the final code may embody the views of as large a proportion of the members as possible and be so framed as to serve the best interests of the profession at large. The report will probably be discussed at the Spring Meeting of the Society in Baltimore.

DEPRECIATION AND OBSOLESCENCE

A committee of five has been appointed by the Council to confer with committees on Depreciation and Obsolescence appointed by sister societies, as to how to determine scientifically the rates for charge against depreciation and obsolescence.

STUDENT BRANCHES

A new student branch has been formed at Syracuse University, making the total number of these branches of the Society twenty-six.

At a meeting of the Yale Mechanical Engineers Club in New Haven on December 10, Prof. William Kent, who recently accepted appointment on the Committee on Student Branches, gave a talk on Engineering and Common Sense, in which he emphasized the importance of observation, absorption and concentration in all phases of education. Mr. C. H. Lambelet, who represented the Secretary, congratulated the branch on their work and

invited the students to visit the rooms of the Society when in New York.

NATIONAL SOCIETY FOR PROMOTION OF INDUSTRIAL EDUCATION

The following Honorary Vice-Presidents were appointed by the Council to attend the convention of the National Society for the Promotion of Industrial Education, held in Philadelphia, December 5-7, 1912: Henry Hess, Charles R. Richards, F. W. Taylor, Morris L. Cooke and A. L. Williston.

CALVIN W. RICE, *Secretary*

ADDITIONAL HOLDERS OF CERTIFICATES

The following names should be added to the list of the holders of Certificates of Indebtedness, published in The Journal for December:

J. D. Cox	Chas. Kirchhoff
R. S. Kent	E. S. Knisely
C. E. Kinne	W. L. Lyall
F. E. Kirby	C. D. Pettis

and for the name of Carl Schwartz should be read F. H. Schwarz.

THE ANNUAL MEETING

The thirty-third Annual Meeting of the Society, held in New York, December 3-6, 1912, was attended by 561 members and 356 guests. The meeting was noteworthy because of the unusually varied professional program which for the first time was largely under the direction of the sub-committees of the Committee on Meetings. There were nine professional sessions and the last, on Friday, was an all-day session devoted to the discussion of industrial management. The attendance at this session was large, indicating a sustained interest in the proceedings up to the end of the convention.

This year for the first time in many years the usual Thursday evening reception and dance was omitted and instead the award of the John Fritz Medal by the John Fritz Medal Board of Award was made on that evening. On the evening previous about 300 attended the dinner in honor of Professor John E. Sweet.

The various details of the convention which showed much forethought and care in their working out, were in charge of either standing or specially organized committees of the Society. The professional sessions were arranged by the Committee on Meetings, Dr. Charles E. Lucke, Chairman, and by the various subcommittees of this committee, covering various phases of mechanical engineering. The Committee on Meetings in New York, F. H. Colvin, Chairman, coöperated with the House Committee, Francis Blossom, Chairman, in caring for the entertainment features of the meetings, and members of these committees acted as chairmen of the sub-committees, Francis Blossom serving at the head of the Committee on President's Reception, H. R. Cobleigh of the Excursion Committee, and Roy V. Wright of the Acquaintanceship Committee.

A bureau of information was maintained in the foyer of the building during the convention which materially aided in the arrangements for excursions and other details of the meetings.

OPENING SESSION, TUESDAY EVENING

The meeting was opened on Tuesday evening in the auditorium of the Engineering Societies Building, with the president's annual address delivered by Dr. Alex. C. Humphreys, on The Present Opportunities and Consequent Responsibilities of the Engineer. Dr. Humphreys called to his aid the addresses made by presidents in the past, quoting such parts as were more particularly applicable to his purpose and concluding with his own ideas as to the education of the engineer and a review of the Society's activities during 1911-1912. Theodore Stebbins, Chairman of the Tellers of Election of Officers, was then called upon to make his report and the following results of the ballots cast were given: President, W. F. M. Goss; Vice-Presidents, James Hartness, I. E. Moultrop, H. G. Stott; Managers, W. B. Jackson, H. M. Leland, Alfred Noble; Treasurer, William H. Wiley. Past-Presidents Swasey, Smith and Meier were appointed to escort Dr. Goss to the platform and an introductory speech was made by Dr. Humphreys in which he offered President Goss the full and complete coöperation and services of the officers, committees and staff of the Society during the progress of his administration. Dr. Goss replied as follows:

I am sure that you readily appreciate the embarrassment which one feels upon being introduced in such a manner as this and before such an audience. It seems commonplace for me to say to you and to all the members of The American Society of Mechanical Engineers that I appreciate the courtesy and generosity which has been shown me, but I feel that I should not be true to myself or fair to you if I did not say it. I understand the significance of this occasion. I deeply appreciate the tribute and I will endeavor so far as I am able to discharge the obligations which you, the members of the Society, have put upon me during the year for which you have elected me as your President. I thank you.

The audience then adjourned to the rooms of the Society on the eleventh floor where the members and their guests met the new officers. Music was rendered during the evening and a collation was served.

WEDNESDAY MORNING SESSION

The annual business meeting was held on Wednesday morning, December 4, in the auditorium, and was followed by professional sessions. The annual reports of the Council and Standing Committees were read and accepted, and the thanks of the Society

tendered to those who had contributed to the work accomplished. The Tellers of Election to Membership reported 328 names acted upon favorably for membership in the Society.

A report was presented by the Committee on Increase of Membership, I. E. Moultrop, Chairman, who called attention to the efforts of the committee to coöperate with the Membership Committee, in an effort to raise the standard of admission.

The Committee on Constitution and By-Laws, Jesse M. Smith, Chairman, explained in detail the amendments to be voted on, and it was moved that these be referred to the membership for letter ballot.

Prof. F. R. Hutton, Honorary Secretary, reported for the committee appointed to write the history of the Society and asked for the coöperation of the membership in including in it details not generally known.

PROFESSIONAL SESSIONS

The professional sessions of this meeting were distinctive in that they were largely the result of the work of sub-committees of the Committee on Meetings. There were nine sessions in all, seven of which were either in charge of sub-committees or of the Gas Power Section, or were representative of the work of professional committees of the Society. Two technical reports presenting the "state of the art" were prepared by sub-committees, one upon the development of machine shop practice during the last decade written by Fred E. Rogers, chairman of the sub-committee on Machine Shop Practice, and the other upon industrial administration prepared by L. P. Alford, secretary of the sub-committee on Administration, with the advice and coöperation of the committee members. The latter report required for the discussion nearly the whole day on Friday. This, the last day of the meeting, when members have usually been departing for their homes, was this year the one at which the greatest interest was evidenced. The address of the chairman of the Gas Power Section reviewing European practice in this field was also of the same general character as the two reports mentioned.

On Wednesday afternoon the entire session was given to the reports of the special committees, among which were included the voluminous report of the Power Tests Committee which

eventually will take the place of the several reports of the Society already issued on the testing of power plant apparatus.

At the time of the appointment of the first sub-committees of the Committee on Meetings it was hoped that their efforts would result in papers in different fields which would bear more or less directly upon other fields of work, even though not closely related to the former. This principle was emphasized at the textile session at which The Principles of Valuing Property by Henry K. Rowell proved of interest to members not identified with the textile industry. Another pleasing feature was an increasing interest in railroad subjects through the efforts of the Sub-Committee on Railroads.

The complete program is published herewith in which the papers and discussion are listed. The papers have been published in The Journal or will appear in this and later issues together with the discussion.

WEDNESDAY EVENING, DINNER TO PROFESSOR SWEET

One of the most delightful features of the meeting and one of the most unique events ever held in the Engineering Building, was the dinner tendered to Prof. John E. Sweet on the evening of December 4 by about 300 of "Professor Sweet's boys" and his friends in the Society, in appreciation of Professor Sweet's work in the organization of the Society. Dr. Alex. C. Humphreys made an address of welcome, and Captain Robert W. Hunt, Prof. Albert W. Smith, Dr. John A. Brashear, and Professor Sweet himself responded to toasts. The songs rendered by Mr. George A. Fleming proved an attractive addition to the program.

An excellent photogravure of Professor Sweet and also of the first Straight Line engine, which used to run the shops at Cornell University, were included in handsome menu cards given to each guest as a souvenir of the dinner, and the table was artistically decorated. Ambrose Swasey, Chairman, F. G. Tallman, Vice-Chairman, E. J. Armstrong, F. A. Halsey, Robert W. Hunt, E. D. Leavitt, William Kent, Charles R. Richards, Albert W. Smith, E. N. Trump, Worcester R. Warner and W. H. Wiley, acted as a committee in charge of the dinner, and were widely congratulated on the success of the evening.

Many telegrams and letters of good wishes were received by Professor Sweet from friends who were unable to participate in the occasion.

THURSDAY EVENING, JOHN FRITZ MEDAL AWARD

On Thursday evening, December 5, the John Fritz Medal for 1912 was publicly awarded at a meeting in the Engineering Societies Building, to Captain Robert Woolston Hunt, a past-president of the Society, for his contribution to the introduction of the Bessemer process in America.

The meeting was presided over by Prof. James F. Kemp, President of the American Institute of Mining Engineers, and grouped about Captain Hunt on the platform were the members of the John Fritz Medal Board of Award. Dr. John A. Brashear made the opening address, his subject being Early Reminiscences of the Steel Industry. E. Gybbon Spilsbury, in the absence of Onward Bates, President of the Board, then presented the medal to Captain Hunt, who responded with an account of his early participation in the steel industry.

After the ceremony the three founder societies, the American Institute of Electrical Engineers, the American Institute of Mining Engineers, and The American Society of Mechanical Engineers, joined in tending a reception to Captain Hunt, to the three societies, and to the members of the American Society of Civil Engineers. A collation was served during the evening.

ENTERTAINMENT OF LADIES

A Ladies Committee, Mrs. Alex. C. Humphreys, Chairman, was again formed to welcome the visiting ladies, and served tea informally in the rooms of the Society on the afternoons of Wednesday and Thursday. Many of the members joined in taking the opportunity for social intercourse afforded by these pleasant occasions.

EXCURSIONS

On Wednesday afternoon two excursions were made: one to the Grand Central Terminal where, through the courtesy of George W. Kittridge, chief engineer of the New York Central & Hudson River R.R., the new construction under way was inspected under the guidance of Carl Schwartz. The main building covers an area on the street level 301 ft. wide and 722 ft. long; below the street level the station is 455 ft. wide and 745 ft. long. In this building which will be used for outgoing passengers only, are located the waiting rooms, concourses, baggage rooms, and

other facilities of travel. The incoming station will be located on Vanderbilt Avenue and will have sub-surface connections with the main building.

The largest single item involved in constructing the terminal was the excavation, which was conducted under very unusual conditions. There could be no interference with the operation of trains, and the proximity of the steel construction and buildings occupied by human beings necessitated taking the greatest precautions. In many places the steel structure had to be erected within 3 or 4 ft. of the rock, the face of which was about 45 ft. high. The total excavation amounted to 3,094,750 cubic yards, about 2,000,000 of which was rock.

Next to the excavation, the steel construction is the largest single item. Over the suburban level, for the purpose of supporting the express-level tracks, covering an area of 38.1 acres, approximately 51,870 tons of steel are used. For viaducts and cross streets, aggregating 9,400 ft., about 1¾ miles, about 14,700 tons of steel are used; in the main building approximately 28,390 tons.

One of the unique features of the Grand Central Terminal is the use of ramps or inclined ways instead of stairways. The suburban business is separated from the through, and the incoming from the outgoing, so that the passengers on any one ramp all move in the same direction.

The track lay-out comprises over 33 miles and consists of two levels, the upper level having 42 tracks, 29 of which are adjacent to platforms, and the lower level having 25 tracks, 17 of which are adjacent to platforms. Both levels have loop tracks for the purpose of turning equipment. The rails at platforms are laid on creosoted timber set in solid concrete, for permanency and clean lines.

There are direct sub-surface connections with the Interborough, Hudson and Manhattan Tubes to Jersey City, Belmont Tunnel to Long Island, and the new Lexington Avenue Subway now under construction, thus establishing an intercommunication of travel between the station and the lines of local transit that will place every nook and corner of greater New York, Long Island and Jersey City in direct touch with it.

The second excursion was to the Waterside Station of the New York Edison Company. Through the efforts of John W. Lieb,

Jr., third vice-president and associate general manager, stations Nos. 1 and 2 were again open to visitors from the Society. John H. Lawrence conducted the party.

On Thursday morning, through the kindness of William Williams, a party of 70 visited Ellis Island Immigration Station, M. F. Brophy acting as guide. On the return trip about 20 took advantage of Dr. C. H. Townsend's invitation to visit the Aquarium. In the afternoon one party went on an inspection trip over the Fourth Avenue Subway upon invitation of chief engineer Alfred Craven of the Public Service Commission. The subway is nominally a four-track structure, but the number of tracks is increased to as many as eight in places where undergrade connections are provided for future extensions. The Fulton Street portion comprises about 1000 ft. of extremely heavy and difficult work. There are six and eight tracks occupying two levels. Ground water was encountered before subgrade was reached and as the material is sand all adjacent buildings had to be underpinned in advance. The two elevated railroads crossing the cut are temporarily supported over it. The front portions of two theatres were shored up over the excavation without interfering with performances. At Flatbush Avenue the new structure was built by tunneling under the west end of the Atlantic Avenue station of the present subway. The tunneling methods were devised by Jacobs and Davies and were very successful. Frederick C. Noble conducted the party.

Still another party inspected the Bush Terminal in Brooklyn with its elaborate system for shipping and receiving freight and handling it to and from the various factories and warehouses at the terminal. Mr. W. C. Brinton acted as guide. On the same afternoon a trip was made to the Keller Mechanical Engraving Company by courtesy of W. H. Keller, general superintendent, and William A. Warman, Mem.Am.Soc.M.E., superintendent and designer. This concern manufactures automatic die-sinking and metal engraving machines and also has a department equipped with these machines where dies are made for the trade. It is the largest company of its kind in the world and has a force of designers, photographers, modelers, die sinkers, hardeners and finishers. Their foundry produces some of the finest bronze castings. Photography plays an important part in the economical production of the work, and Mr. Warman has devised a complete

photographic department using paper negatives. The party was under the guidance of E. A. Suverkrop.

Mr. Suverkrop also conducted an excursion to the August Griffoul Brothers Company, Newark, N. J., on Friday morning. Mr. Griffoul and his two brothers learned the art of molding with Liard of Paris, France. Their work is gold, silver, bronze and iron casting of the highest class. In France they molded work from the hands of Rodin, and in this country they have cast work for all the eminent sculptors, St. Gaudens, James E. Fraser, etc. The trip to the Navy Yard by invitation of Capt. Albert Gleaves, also on Friday morning was especially interesting this year as the party was able to go over the Wyoming, the largest battleship in commission, then in drydock, and the New York, recently launched and now being equipped, which will be the largest battleship. Lieutenant-Commander W. B. Tardy acted as guide. In the afternoon, the courtesy of an inspection trip over the Pennsylvania Terminal and Sunnyside yards on Long Island was offered by F. L. Sheppard, general superintendent of the New Jersey Division. The party was conducted by William Couper. The new railway postoffice at the terminal was open for inspection through the kindness of Postmaster Edward M. Morgan.

About fifty made the excursion to the Woolworth Building on Saturday morning instead of on Thursday afternoon as scheduled. By the kindness of the architect, Cass Gilbert, the party was permitted to go to the top of the building and to inspect the entire power plant.

A number of additional excursions were provided that individuals might take at their own election. These included a view of the collection of firearms owned by A. W. Lawrence, inspection of the Port Morris Power Station, the Singer tower and power plant, Aqueduct work, Museum of Safety devices, and the following manufacturing plants: Crocker-Wheeler Company, Ampere, N. J.; Henry R. Worthington, Harrison, N. J.; Davis-Bournonville Company, Marion, N. J.; J. H. Williams Company, Brooklyn, N. Y.; Pond Machine Tool Company, Plainfield, N. J.; National Lead Company, Brooklyn, N. Y.; Goldschmidt Thermit Company, Jersey City, N. J.; Joseph Dixon Crucible Company, Jersey City, N. J.; E. W. Bliss Company, Brooklyn, N. Y.; De La Vergne Machine Company, New York.

RESOLUTIONS OF THANKS

During the professional session of Friday, the following resolutions of thanks were unanimously adopted:

Whereas the members and guests of The American Society of Mechanical Engineers at the Annual Meeting, December 1912, have again been accorded opportunities for participating in both the professional and social features of the meeting,

Be It Resolved that on behalf of the visiting members and guests the Secretary extend the thanks of the Society to the Committee on Meetings and to the sub-committees holding sessions, for the excellence of the professional program; to the Committee on Meetings of the Society in New York for their arrangements for the reception of guests; and to the House Committee and the Committee on President's Reception, the Excursion Committee, the Acquaintanceship Committee and the Ladies Committee, for the entertainment they provided; and

Be It Resolved further that the Secretary express the appreciation and thanks of the meeting to the various firms and institutions which extended their hospitality to the Society and permitted members to inspect these various buildings and points of interest.

PROGRAM

Tuesday Evening, December 3

President's Address: THE PRESENT OPPORTUNITIES AND CONSEQUENT RESPONSIBILITIES OF THE ENGINEER, Alex. C. Humphreys.

Reports of Tellers of Election, of Officers and introduction of the President-Elect.

President's Reception in the rooms of the Society.

Wednesday Morning, December 4

Business meeting. Reports of the Council, tellers of election of membership, standing committees. Amendment to Constitution under C57, relating to election of members and membership grades. New business.

SIMULTANEOUS SESSIONS FOLLOWING BUSINESS MEETING

POWER PLANT SESSION

DIMENSIONS OF BOILER CHIMNEYS FOR CRUDE OIL, C. R. Weymouth.

No discussion.

TESTS OF A 1000-H.P. 24 TUBES HIGH B. & W. BOILER, B. N. Bump.

Discussed by W. D. Ennis, William Kent, J. H. Brown, D. S. Jacobus, C. B. Young.

AIR IN SURFACE CONDENSATION, George A. Orrok.

Discussed by G. J. Foran, A. G. Christie, H. A. Everett.

PROPERTIES OF SATURATED AND SUPERHEATED AMMONIA, Wm. Earl Mosher.

No discussion.

PHYSICAL PROPERTIES OF ANHYDROUS AMMONIA, L. S. Marks and F. W. Loomis. (Presented through the courtesy of The American Society of Refrigerating Engineers.)

No discussion.

EXPERIMENTS WITH NORTH DAKOTA LIGNITE IN A STEAM POWER PLANT AND A GAS PRODUCER, Calvin H. Crouch.

No discussion.

THE BALTIMORE SEWERAGE PUMP VALVE, A. F. Nagle.

No discussion.

TEXTILE SESSION

THE PRINCIPLES OF VALUING PROPERTY, Henry K. Rowell.

Discussed by Charles Fitch, C. J. H. Woodbury, C. T. Main, C. T. Plunkett.

THE POWER PLANTS OF TEXTILE MILLS, John A. Stevens.

Discussed by Charles Fitch, C. T. Main, C. T. Plunkett, C. C. Thomas, C. J. H. Woodbury, W. H. Cary, C. W. Burleigh.

GAS POWER SECTION

Chairman's Address: RECENT DEVELOPMENT OF GAS POWER IN EUROPE, H. J. Freyn.

Discussed by Wm. T. Magruder, D. G. Baker, Mr. Chubb, W. R. Haynie.

HEAVY OIL FOR USE IN INTERNAL-COMBUSTION ENGINES, Irving C. Allen.

Wednesday Afternoon

Reports of special committees, including Power Tests, Hoisting and Conveying, Standard Cross-Section Symbols, Involute Gears, Standardization of Catalogues, Flanges, Pipe Threads.

RECEPTION

Reception to members and guests of the Society, given by the Ladies' Committee in the rooms of the Society.

Wednesday Evening

Reception and subscription dinner tendered to Prof. John E. Sweet, Honorary Member and Past-President, in celebration of his eightieth birthday and in recognition of his services to the engineering profession.

Thursday Morning, December 5

JOINT SESSION IN CHARGE OF SUB-COMMITTEES ON MACHINE SHOP PRACTICE AND IRON AND STEEL

(Papers contributed by Sub-Committee on Machine Shop Practice)

Report of Sub-Committee: THE DEVELOPMENT OF MACHINE SHOP PRACTICE DURING THE LAST DECADE.

No discussion.

THE VAUCLAIN DRILL, A. C. Vauclain and Henry V. Wille.

Discussed by J. S. Bancroft, H. P. Fairfield.

EFFICIENT PRODUCTION OF CYLINDRICAL WORK, C. H. Norton.

Discussed by R. H. Rice, H. P. Fairfield, A. A. Alden, Wm. Kent.

INCREASE OF BORE OF HIGH-SPEED WHEELS BY CENTRIFUGAL STRESS, Sanford A. Moss. (Contributed through the courtesy of the Boston Local Committee.)

Discussed by R. H. Rice, Wm. Kent, W. H. Kenerson, E. A. Sperry.

INVESTIGATION OF EFFICIENCY OF WORM GEARING FOR AUTOMOBILE TRANSMISSION, Wm. H. Kenerson.

Discussed by Elmer A. Sperry, R. H. Rice, Wm. Kent, S. A. Moss, W. C. Marshall.

THE STRENGTH OF GEAR TEETH, Guido H. Marx.

Discussed by L. D. Burlingame, R. E. Flanders, W. S. Huson, W. H. Diefendorf, J. S. Bancroft, Wm. Kent, W. H. Kenerson, C. H. Norton, W. C. Marshall, T. M. Phetteplace.

(Paper contributed by Sub-Committee on Iron and Steel)

CASE CARBONIZING, Marcus T. Lothrop.

Discussed by B. E. Bosler, R. R. Abbott, Albert Sauveur, H. D. Hibbard, A. H. Annin, J. A. Matthews.

RAILROAD SESSION

(Papers contributed by Sub-Committee on Railroads)

TRAIN LIGHTING, H. A. Currie and Benjamin F. Wood.

Discussed by R. M. Dixon, W. L. Bliss, Mr. Rockleton, C. D. Young, Mr. Sloan.

FACTORS IN THE SELECTION OF LOCOMOTIVES IN RELATION TO THE ECONOMICS OF RAILWAY OPERATIONS, O. S. Beyer, Jr.

Discussed by H. H. Vaughan, Simon Hoffman, C. C. Trump, Mr. Gibbs, C. D. Young, G. R. Henderson, F. F. Gaines, W. R. Keisel, Jr.

CEMENT SESSION

(Papers contributed by Sub-Committee on Cement Manufacture)

SOME REMARKS ON THE DEPRECIATION FACTOR IN THE COST OF PRODUCING PORTLAND CEMENT, Frederick H. Lewis.

Discussed by G. S. Brown.

THE PREVENTION OF MISSED FIRES IN BLASTING, W. H. Mason.

THE DETERIORATION AND SPONTANEOUS COMBUSTION OF GAS COAL, Perry Barker.

Papers discussed as a whole by R. K. Meade, R. C. Carpenter, Mr. Sayer, Mr. Brobston, P. H. Wilson.

Thursday Afternoon

SESSION ON FLUID FLOW

MEASUREMENT OF AIR IN FAN WORK, Chas. H. Treat.

No discussion.

THE V-NOTCH WEIR METHOD OF MEASUREMENT, D. Robert Yarnall. (Contributed through the courtesy of the Philadelphia Local Committee.)

Discussed by W. S. Giele, J. H. Brown, F. N. Connet.

THE CENTRIFUGAL BLOWER FOR HIGH PRESSURES, Henry F. Schmidt.

Discussed by R. H. Rice, C. G. deLaval, C. P. Crissey, S. A. Moss, A. E. Guy, W. H. Carrier, C. J. H. Woodbury.

MEASUREMENT OF NATURAL GAS, Thos. R. Weymouth.

Discussed by C. G. deLaval, E. A. Hitchcock, C. J. Bacon, C. C. Thomas.

RECEPTION

Reception to members and guests of the Society, given by the Ladies' Committee in the rooms of the Society.

Thursday Evening

The John Fritz Medal for 1912 was conferred upon Robert Woolston Hunt, Past-President of the Society, "for his contributions to the early development of the Bessemer process." Following the ceremonial there was a joint reception to Mr. Hunt and to the members and ladies of the four American engineering societies.

Friday Morning, December 6

ADMINISTRATION SESSION

Report of Sub-Committee on Administration: THE PRESENT STATE OF THE ART OF INDUSTRIAL MANAGEMENT.

Discussed by C. B. Going, H. P. Gillette, A. H. Church, C. B. Thompson, H. L. Gantt, J. G. Aldrich, R. T. Kent, H. M. Wilcox, F. A. Waldron, F. W. Taylor, F. G. Coburn, David Van Alstyne, Hugo Diemer, C. G. Barth, A. C. Humphreys, H. P. Kendall, Tracy Lyon, D. S. Kimball, H. H. Vaughan, Wm. Kent, R. R. Keely, J. A. Bursley, T. R. Wooley, E. C. Church.

AXIOMS CONCERNING MANUFACTURING COSTS, Henry R. Towne.

Discussed by A. C. Jackson, Augustus Smith, Wm. Kent.

MEASURING EFFICIENCY IN MANUFACTURING, Edward B. Passano.

No discussion.

NEWLY-ELECTED OFFICERS

An account of the career of Dr. W. F. M. Goss, elected president of the Society for 1912-1913, is herewith given; and also biographies of the three newly-elected officers who have not previously served on the Council: W. B. Jackson, H. M. Leland and Alfred Noble, Managers.

WILLIAM FREEMAN MYRICK GOSS

President Am.Soc.M.E.

William Freeman Myrick Goss was born in Barnstable, Mass., October 7, 1859. In the fall of 1877 he entered the then recently established mechanics arts course at the Massachusetts Institute of Technology. Upon completion of the two-year course he was appointed instructor in practical mechanics at Purdue University and at once began there the work of establishing shop laboratories. His first class of five students was given instruction in those lines of work in which he himself had just been trained. From a meager beginning, the outlook broadened rapidly. The equipment was extended, the number of students increased, and new shop laboratories were built. In 1883 he became professor of practical mechanics, a title which he held for seven years. When he began, there was no college west of the Allegheny Mountains giving systematic courses in shop practice, and there was no manual training work in any American high school. He devised courses of practice and developed series of lectures by means of which principles established in the shops could be given wider application. It was a day when school officials were becoming interested in training students in the manual arts, and many distinguished visitors came to see the work of the Purdue laboratories. The great cities of Chicago, Toledo, Louisville and Indianapolis each in turn sought its aid in the establishment of their manual training schools. Certain forms of equipment, especially forges and lathes, originally de-

signed and constructed at Purdue, were made and supplied as complete equipment to school boards in distant localities where new courses of shop practice were being organized. In many such ways the work at Purdue had an important part in ushering in an educational movement of unusual significance.

In 1889, after ten years of this work, Professor Goss was given a leave of absence, and took up his residence in Boston, where he continued from April of that year to a year from the following September. Some work was done at the Massachusetts Institute of Technology, but the greater part of the time was given to self-directed reading and study. In the spring of 1890 he was appointed professor of experimental enginering, and he undertook the active duties of his new office in the fall of that year. Having developed laboratories for elementary training, it was now his task to build laboratories for advanced engineering work. A modest steam engineering laboratory equipped with a compound Corliss engine and a few testing machines was soon in operation. Plans for an extensive engineering building (Purdue's present engineering laboratory) were developed and by the fall of 1891 a portion of the building was constructed. A significant part of the equipment of the new laboratory was a locomotive testing plant designed to serve in an experimental study of locomotive problems in much the same way that an experimental stationary plant could be used in studying the problems of design affecting the performance of stationary engines. This locomotive testing plant was the first of its kind. It was designed in the summer of 1891 while the building which was to contain it was in the process of erection, and was in successful operation in the late fall of the same year. An incident in the process of installing this plant was that of transporting a 100,000-lb. locomotive over the corn-fields and highways which intervened between the nearest track and the laboratory, a distance by the course taken of about a mile and a half. The opportunities which were presented to its possessors at once attracted the attention of motive power men and of steam engineers. So meager was the information concerning the performance of locomotives that every fragment of truth, however simple or easily obtained, at once became a matter of public interest. The evaporative capacity of the locomotive boiler, its efficiency at difficult rates of power, the power and efficiency of the cylinders, and the effect upon power and efficiency of changes in speed or cut-off were all matters which

previous to the introduction of this plant had been but little understood even by those best informed. The behavior of the various parts of the machine as a mechanism and especially the effects produced by the action of the counterbalance in the locomotive drive wheels were all matters concerning which people had theories, but which were first actually developed by the accurate processes of the laboratory at the Purdue plant. Associations of railroad men gave their encouragement and sometimes financial assistance in increasing the output of the plant. The Master Car Builders' Association made the Purdue laboratories its official testing station and was instrumental in installing there a considerable amount of useful and expensive apparatus. The laboratory became an active center for testing not only locomotives, locomotive fuels and locomotive lubricants, but also details of car construction such as wheels, axles, draft-gears, couplers and brake-shoes. The problems awaiting solution were always numerous, and the professor in charge was kept busy outlining the means to be employed in solving them. He was in the beginning responsible not only for the effective use of the railroad equipment to which reference has already been made, but also for the development of laboratories and courses in materials testing, in hydraulics and in the general field of theoretical and applied thermodynamics. He built buildings, purchased and installed equipment, and in many cases the equipment installed was of his design, and he was required to meet the reasonable expectations of an ever increasing body of students. Hundreds of men who were students at Purdue in the early nineties can testify to the variety of the activities which in their day were in progress in the engineering laboratories.

In 1899 Professor Goss was again granted a year's leave of absence which he spent in travel and study abroad, chiefly in Germany. Upon his return he was appointed Dean of the Schools of Engineering, an office which he continued to hold throughout the remaining eight years of his residence at Purdue. In 1907 he resigned his position at Purdue, after twenty-eight years of service, to take up what seemed to him the larger and more responsible duties of his present office, namely, that of Dean of the College of Engineering of the University of Illinois.

Professor Goss was given the honorary degree of Master of Arts by Wabash College in 1888 and the honorary degree of

Doctor of Engineering by the University of Illinois in 1904. He has been a member of the Society since 1885, and a member of the American Society for Testing Materials and of the Society for the Promotion of Engineering Education from their organization. He was a member of the Executive Committee of the National Advisory Board on Fuels and Structural Materials, and a member of the Jury of Awards in the Transportation Department of the World's Fair of Chicago in 1893. He is a member of the Master Car Builders' Association, of the Master Mechanics' Association, of the Illinois Academy of Science and of the Western Society of Engineers. He is a fellow of the American Society for the Advancement of Science, a member and past-president of the Western Railway Club and was the Chairman of the Advisory Committee organized by the Pennsylvania Railway Company to direct its work in locomotive testing at the Louisiana Purchase Exposition. For many years he was a contributing editor to the Railroad Gazette. His contributions to technical literature have been numerous. Probably his best known work is that which deals with the locomotive. His books on Locomotive Performance and Locomotive Sparks are records of personal researches which are known to most railroad men and to most students of locomotive design. Numerous researches conducted under the patronage of various associations are available only in the proceedings of these associations. Besides these, two noteworthy pieces of work were done under the patronage of the Carnegie Institution of Washington, the results of which are presented in two volumes, one entitled High Steam Pressures in Locomotive Service and the other Superheated Steam in Locomotive Service.

MANAGERS

WILLIAM BENJAMIN JACKSON

William B. Jackson was born June 22, 1870 at Kennett Square, Pa. He received his education at the Pennsylvania State College from which he was graduated in 1890 with the degree of B.S., and in 1895 he received the advance degree of M. E. From 1890 to 1893 he was in the El Paso County Bank at Colorado Springs, Colo. and the following year had charge of the Pennsylvania Mining Exhibit at the Chicago World's Fair, following which he joined the United Electric Light and Power Company of New

York. Later he accepted a position with the Stanley Electric Manufacturing Company in their shops and testing department and subsequently was made engineer in charge of the specification department. In 1895 he was transferred to Chicago as engineer for the northwest, in charge of all installation and engineering work in that district. Later he became manager of the Lowell Water and Light Company and Peninsular Light, Power and Heat Company, which transmitted electric power from Lowell, Mich., to Grand Rapids and there distributed it. This was the first high tension electric transmission system to be started east of the Rocky Mountains. There he devised a system of charges for electric light and power based upon a readiness to serve to which was added an equitable charge for each unit of power actually used, a system which has become widely recognized as an equitable one for both customer and supply company. In 1897 he was stationed at the West New Brighton plant of the New York and Staten Island Electric Company, and later assumed the duties of superintendent and chief engineer of that system. In 1899 Mr. Jackson entered the employ of the Colorado Electric Power Company with the duties of general superintendent and chief engineer. In 1901 he reentered the employ of the Stanley Electric Manufacturing Company as traveling engineer, having charge of the examinations of and reports upon all lighting and power projects brought to the attention of his company. While in this position he laid out in detail the complete electrical equipment, including the making of the estimates and specification for the 20,000-h.p. hydroelectric generating station of the Yorkhaven Water and Power Company upon the Susquehanna River, and carried out work for this company in Austria and Hungary. Up to this time his experience included pioneer work in the manufacture of polyphase electrical apparatus and the installation and operation of central stations and electrical transmissions, including the early paralleling of engine driven and water driven alternators, and the handling and repair of high voltage transmission circuits while alive. In 1902 he left the Stanley Manufacturing Company and became associated with Dugald C. Jackson of Madison, Wis., in the consulting engineering business under the firm name of D. C. and Wm. B. Jackson. In 1907 his firm moved from Madison and established its main office in Chicago, and shortly after a second office in Boston, Mass. It has been occupied

in the design and supervision of the construction of important electrical projects; upon examinations and reports upon engineering projects and in the laying out and carrying out of improvements of the physical and operating features of electrical properties; the detailed valuations of electrical properties; the determination of just rates for charges of service of electric light, electric railway and telephone properties; and other matters of like character.

Mr. Jackson is a member of the American Institute of Electrical Engineers, the American Society of Civil Engineers, the American Gas Institute, the Western Society of Engineers, the National Electric Light Association, and the American Street and Interurban Railway Association.

HENRY MARTYN LELAND

Henry Martyn Leland was born at Danville, Vt., February 16, 1843. His early life was spent upon a farm and his education was such as was afforded in the country schoolhouse. After leaving school he worked for one year at making carriage wheels at Worcester, Mass., and in 1859 was apprenticed to learn the machinists' trade with the Geo. Crompton Loom Works at Worcester, now the Knowles-Crompton Loom Works. Completing this apprenticeship in 1862, he worked during the balance of the Civil War in the U. S. Armory, Springfield, Mass., making the tools that were used in the manufacture of rifles for the war. After the war he began a service of one year in the Colts Armory at Hartford, Conn., and then returned to Worcester where he worked as machinist and tool maker. Believing the Brown & Sharpe Manufacturing Company of Providence to represent the highest type of manufacturing concern he moved to Providence in 1872 and entered their employ as tool maker, becoming foreman of the sewing machine department in a few years. Mr. Leland remained with this company about twenty years, when he yielded to the appeals of the growing west.

In 1890 he established the Leland & Faulconer Manufacturing Company in Detroit, Mich., devoting his energies to the manufacture of special machinery, particularly the internal-combustion engine for naphtha launches. This naturally led to an early identification with the automobile industry, and the Cadillac Automobile Company was organized that he might have a market

for his engines. In 1905 the Leland & Faulconer Manufacturing Company and the Cadillac Automobile Company were consolidated to form the Cadillac Motor Car Company, with Mr. Leland as its manager, a position which he still holds.

ALFRED NOBLE

Alfred Noble was born August 7, 1844 at Livonia, Mich. At the age of eighteen he enlisted as a private in the 24th Michigan Infantry, and served continuously in the army of the Potomac until February 1865; he was on post duty until June 1865, and was finally discharged with the rank of sergeant at the close of the war. Mr. Noble then obtained a position as clerk in the War Department at Washington, and while there prepared himself to enter the University of Michigan. He was graduated in 1870 although he was absent much of the time during his course, being employed as clerk and then as assistant engineer on river and harbor work. After graduation he was placed in local charge of the improvement of St. Mary's Falls Canal and St. Mary's River where he continued for twelve years. During this period the first great masonry lock was built at the Sault, which was at the time of its construction the largest canal lock in the world. In 1882 Mr. Noble resigned from the government service and went to Louisiana where he was resident engineer on the construction of the Red River Bridge at Shreveport. In the spring of 1883 he was appointed general assistant engineer of the Northern Pacific Railroad. He continued in the position for three years, and had charge of the building of bridges across Snake River, Clark's Fork of the Columbia River and St. Louis Bay, and the foundations and erection of the Marent Gulch viaduct. In August 1886 Mr. Noble came to New York to supervise the construction of the Washington steel arch bridge over the Harlem River. In 1887 he took charge of the erection of the Cairo bridge over the Ohio River, and was also connected with the construction of the great cantilever bridge over the Mississippi River at Memphis. From 1892 to 1894 as assistant chief engineer he had charge of the Bellefontaine and Leavenworth bridges over the Mississippi, as well as the bridge at Alton.

Mr. Noble came into national prominence through his appointment in 1895 as a member of the first Nicaragua Canal Commission. The report of this commision, that while the high level route proposed by the Maritime Canal Company was feasible, its

adoption was inadvisable until alternative routes had been explored, lead to the appointment of the second Nicaragua Canal Commission of 1897, and later of the Isthmian Canal Commission of 1899, of which Mr. Noble was also a member. This is the body which determined on the Panama route as the most practicable.

Mr. Noble's work on the United States Deep Waterway Commission from 1897 to 1900 is hardly less important in public service than his work on the Isthmian Canal Commission. In 1902 he was appointed chief engineer of the East River Division of the New York extension of the Pennsylvania Railroad, in which capacity he served until 1909.

He is a past-president of the American Society of Civil Engineers, the Western Society of Engineers, and a member of the Institution of Civil Engineers of Great Britain.

REPORT OF FIFTEENTH INTERNATIONAL CONGRESS ON HYGIENE AND DEMOGRAPHY

To the Council:

The Fifteenth International Congress on Hygiene and Demography was held in Washington, D. C., from September 23 to 28, inclusive, in response to an invitation extended by the President of the United States. These congresses are held at irregular intervals of a few years apart and are one of the many world-wide movements to disseminate knowledge. Their specific object is to increase the world's knowledge of and to encourage the study of matters relating to public health and welfare and to vital and social statistics and their application to the comparative study of races.

The congress was divided into nine sections, as follows: (1) Hygienic Microbiology and Parasitology; (2) Dietetic Hygiene; Hygienic Physiology; (3) Hygiene of Infancy and Childhood; School of Hygiene; (4) Industrial and Occupational Hygiene; (5) Control of Infectious Diseases; (6) State and Municipal Diseases; (7) Hygiene of Traffic and Transportation; (8) Military, Naval and Tropical Hygiene; (9) Demography. In addition to these sections, there was organized an exhibition, illustrating human welfare and demography, which was open from September 16 to October 4.

Some 27 foreign governments and 48 states of the Union accepted the invitation to attend this congress, which was the first of the series to be held on the continent of America. The exhibition was participated in by many federal bureaus, states, cities, scientific organizations, and institutions of learning and research. This was the first exhibition in the United States which covered all phases of hygiene, although there have been many exhibitions of similar character confined to single problems.

Among the exhibits, there were many which showed careful preparation and were worthy of their contributors. Especially noted were the exhibits made by U. S. Public Health Service, the

U. S. Army, the U. S. Navy, the American Museum of Natural History of New York, New York State, the Metropolitan Sewerage Commission of New York, the New York City Department of Health, various State Boards of Health, the exhibitions on Sex Hygiene, on Mental Hygiene, on Prevention of Industrial Accidents, and on Welfare of Employees in Manufacturing Establishments.

Many delegates from all parts of the world attended the congress and exhibition, and the scientific delegates representing foreign countries were of a high order.

The congress was most successful. The papers presented in all the sections were of a distinctly high character, well worthy of the efforts which were made to make this congress notable in the series.

As sanitary science has passed the stage of infancy and has become widely recognized, the purpose of the congress and exhibition was to bring before the public, practical methods for the prevention of diseases and the improvement of living conditions.

The object of these congresses is to effect this result

a By a conference of the foremost sanitary authorities from all parts of the world, whereby the latest data on sanitation and the prevention of diseases would be presented for discussion.

b By educating the general public to the necessity of concerted effort by extending and coördinating the work of federal, state, municipal and private health agencies.

c By demonstrating the best work done in public health, civic welfare and the prevention of disease through an exhibition.

As former congresses have been held in the capitals of Europe, it has not been possible for many American delegates to attend. At this congress there were many American scientists and others interested in hygiene, who had an opportunity of meeting many of the best foreign sanitary specialists. This opportunity will, undoubtedly, tend to improve the conditions existing in the United States, such as the extension of our system of vital statistics, the prevention of infant mortality, the sanitary control of food supplies, school and industrial hygiene, typhoid fever and hookworm, the cure and prevention of tropical diseases, and federal, state

and municipal organization for the preservation of public health.

The transactions of the congress will be published so that the knowledge may become available to all interested in the matters presented.

As the engineer is becoming more and more an important factor in improving hygienic conditions in our modern civilization, it is a source of great satisfaction to know that the engineers of this country took a deep and active interest in this congress.

Respectfully submitted,

H. DE B. PARSONS, *Honorary Vice-President*

A PROPOSED CODE OF ETHICS FOR ENGINEERS

A committee was appointed by the Council on April 9, 1912 to draft a code of ethics for adoption by the Society. At the Council Meeting of December 6, this Committee submitted a proposed code which it recommended should be presented to the Society's members for comment and criticism before any action was taken upon it. The proposed code is printed herewith. Members are urged to give it careful study and to forward to the Secretary any criticisms or suggestions for its improvement.

The basis of the present code is that adopted by the American Institute of Electrical Engineers and that now before the Boston Society of Civil Engineers for adoption, with additional sections, one in particular providing for a new standing committee of the Society. It has seemed to the Committee that any code which could be drafted would need to be improved, modified and added to by the results of experience, and that this work is important enough to the profession's welfare so that a special committee might well devote time to it. Such a committee would be in effect an arbitration committee, and its decisions would serve to put on record the consensus of the profession as to what constitutes honorable professional conduct.

In presenting the proposed code to the Council, the Committee emphasizes the fact that no code can define the duties and obligations of engineers under all possible circumstances and the proposed code merely attempts to cover those relations concerning which questions most frequently arise in engineering practice.

The Committee also urges that since the maintenance of honorable professional conduct by its members is as important to the welfare of the profession as wide knowledge and sound judgment on technical matters, it is as properly a function of the Society to furnish its members with some guide as to proper standards of professional conduct as it is to aid them by the formulation of standards relating to technical matters.

The code follows:

PRELIMINARY DRAFT OF CODE OF ETHICS

A GENERAL PRINCIPLES

1 It is not assumed that this code shall define in detail the duties and obligations of engineers under all possible circumstances. It is an axiom that engineers in all their professional relations should be governed by principles of honor, honesty, strict fidelity to trusts imposed upon them and courteous behavior toward all. The following sections are framed to cover situations arising most frequently in engineers' work.

2 It is the duty of engineers to satisfy themselves to the best of their ability that the enterprises with which they become identified are of legitimate character. If an engineer after becoming associated with an enterprise finds it to be of questionable character, he should sever his connection with it as soon as practicable, avoiding in so doing reflections on his previous associates.

B THE ENGINEER'S RELATIONS TO CLIENT OR EMPLOYER

3 The engineer should consider the protection of a client's or employer's interests his first obligation, and therefore should avoid every act contrary to this duty. If any other consideration, such as professional obligations or restrictions, interfere with his meeting the legitimate expectation of a client or employer, the engineer should so inform him.

4 An engineer cannot honorably accept compensation, financial or otherwise, from two or more parties having conflicting interests without the consent of all parties. The engineer, in whatever capacity, whether consulting, designing, installing, or operating, must not accept commissions, directly or indirectly, from parties dealing with his client or employer.

5 An engineer called upon to decide on the use of inventions, apparatus, or anything in which he has a financial interest, should make his status clearly understood by those employing him,

6 An engineer in independent practice may be employed by more than one party, when the interests of the several parties do not conflict; and it should be understood that he is not expected to devote his entire time to the work of one, but is free to carry out other engagements. A consulting engineer permanently retained by a party, should notify other prospective clients of this affiliation before entering into relations with them, if, in his opinion, the interests might conflict.

7 Before any consulting engineer takes over the work of another consulting engineer he should ask the client his reasons for desiring to change engineers and unless the consulting engineer is entirely satisfied that the client has good and sufficient reasons for making the change he should confer with the present incumbent before accepting the work.

8 Consultations should be encouraged in cases of doubt or unusual responsibility. The aim should be to give the client the advantage of collective skill. Discussions should be confidential. Consulting engineers should not say or do anything to impair confidence in the engineer in charge unless it is apparent that he is wholly incompetent or the interests of the profession so require.

9 Engineers acting as experts in legal and other cases, in making reports and testifying, should not depart from the true statement of results based on sound engineering principles. To base reports or testimony upon theories not so founded is unprofessional.

10 An engineer should make every effort to remedy dangerous defects in apparatus or structures or dangerous conditions of operation, and should immediately bring these to the attention of his client or employer. As failure of any engineering work reflects upon the whole profession, every engineer owes it to his professional associates as well as to himself that a reasonable degree of safety be provided in all work undertaken.

C OWNERSHIP OF ENGINEERING RECORDS AND DATA

11 It is desirable that an engineer undertaking for others work in connection with which he may make improvements, inventions, plans, designs or other records, should first enter into an agreement regarding their ownership.

12 If an engineer uses information which is not common knowledge or public property, but which he obtains from a client or employer, resulting in plans, designs, or other records, these should be regarded as the property of his client or employer.

13 If a consulting engineer uses only his own knowledge, or information which by prior publication, or otherwise, is public property and obtains no engineering data from a client or employer, except performance specifications or routine information; then in the absence of an agreement to the contrary, the results

in the form of inventions, plans, designs, or other records should be regarded as the property of the engineer, and the client or employer should be entitled to their use only in the case for which the engineer was employed.

14 All work and results accomplished by an engineer in independent practice in the form of inventions, plans, designs, or other records, which are outside of the field of engineering for which a client or employer has retained him, should be regarded as the engineer's property unless there is an agreement to the contrary.

15 When an engineer or manufacturer builds apparatus from designs supplied to him by a customer, the designs remain the property of the customer and should not be duplicated by the engineer or manufacturer for others without express permission. When the engineer or manufacturer and a customer jointly work out designs and plans or develop inventions, a clear understanding should be reached before the beginning of the work regarding the respective rights or ownership in any inventions, designs, or matters of similar character, that may result.

16 Any engineering data or information which an engineer obtains from his client or employer, or which he creates as a result of such information, must be considered confidential by the engineer; and while he is justified in using such data or information in his own practice as forming part of his professional experience, its publication without express permission is improper.

17 Designs, data, records and notes made by an employe and referring exclusively to his employer's work, should be regarded as his employer's property.

18 A customer, in buying apparatus, does not acquire any right in its design, but only the use of the apparatus purchased. A client does not acquire any right to the plans made by a consulting engineer except for the specific case for which they were made, unless there is an agreement to the contrary.

D THE ENGINEER'S RELATIONS TO THE PUBLIC

19 The engineer should endeavor to assist the public to a fair and correct general understanding of engineering matters, to extend the general knowledge of engineering, and to discourage the appearance of untrue, unfair or exaggerated statements on engineering subjects in the press or elsewhere, especially if these

statements may lead to, or are made for the purpose of, inducing the public to participate in unworthy enterprises.

20 Technical discussions and criticisms of engineering subjects should not be conducted in the public press, but before engineering societies or in technical publications.

21 It is desirable that the first technical descriptions of inventions, or other engineering advances should not be made through the public press, but before engineering societies or through technical publications.

22 It is unprofessional to give an opinion on a subject without being fully informed as to all the facts relating thereto and as to the purposes for which the information is asked. The opinion should contain a full statement of the conditions under which it applies.

23 Engineers engaged in private practice should limit their advertising to professional cards and modest signs in conformity with the practice of other professions.

E THE ENGINEER'S RELATIONS TO THE ENGINEERING FRATERNITY

24 The engineer should take an interest in and assist his fellow engineers by exchange of general information and experience, by instruction and similar aid, through the engineering societies, the engineering schools, or other means. He should endeavor to protect all reputable engineers from misrepresentation.

25 The engineer should take care that credit for engineering work is attributed to those who, so far as his knowledge of the matter goes, are the real authors of such work.

26 Criticism of the work of one engineer by another should be broad and generous with the facts plainly stated. The success or failure of one member reflects credit or discredit on the whole profession.

27 The attitude of superiors toward subordinates should be that of helpfulness and encouragement. The attitude of subordinates to superiors should be one of loyalty and diligent support. The treatment of each by the other should be open and frank.

28 The attitude of an engineer toward contractors should be one of helpful coöperation. Tact and courtesy should be combined with firmness. An engineer should hold a judicial attitude toward both parties to a contract for whose execution he is responsible.

29 An engineer in responsible charge of work should not permit non-technical persons to over-rule his engineering judgment on purely engineering grounds.

F INTERPRETATION

30 If two or more engineers, members of this Society, disagree as to the interpretation of this code, or as to the proper rules of conduct which should govern them in professional relations to each other, they may agree to refer the matter to a standing committee of the Society on the interpretation of the code. Each party shall submit a statement of his position in writing, and the committee shall render a decision. A permanent record shall be made of the cases so submitted and decided.

31 Amendments or addtions to this code may be made by the standing committee on interpretation of the code, subject to the approval of the Council.

CHAS. WHITING BAKER, *Chairman*
CHAS. T. MAIN,
E. D. MEIER
SPENCER MILLER
C. R. RICHARDS
Committee on Code of Ethics

REPORT OF COMMITTEE ON NATIONAL MUSEUM

The value of museums as educational factors has been recognized by the foremost nations of all periods of civilization. There are historical museums of arms and instruments of destruction, museums of costumes, of natural history, of paintings and sculpture, and of fabrics of various kinds. Liberal sums are spent annually by archeological societies for excavations in foreign lands tending to resurrect the scanty relics of vanished empires, great in the dawn of civilization.

The great works of the engineer and mechanic built upon scientific research, which have given man the command and the use of the forces of nature, to an extent no Pharaoh nor Caesar could have imagined in his wildest dreams, have had but scant recognition in literature, in art and in collections.

That national museums illustrative of this greatest uplift of humanity should be created, is recognized by all who are able to understand and estimate their paramount importance. Germany has erected the first comprehensive museum of the masterpieces of science and the technical arts at Munich.

In less than five years their marvellous success in covering with important exhibits many acres of floor space in a former art gallery and a spacious cavalry barracks loaned by the Bavarian Government, encouraged the managers to invest the millions cheerfully supplied by German industrials in a permanent building on an island in the Isar, now nearing completion.

Last April a commission of five, with as many engineer assistants, was sent to this country to look for more contributions of machines, models, drawings, etc., to enable them to add an American section to each of their main divisions and to encourage American engineers to begin a similar movement.

America owes its greatness to the buoyant courage and skill with which its artisans and engineers accepted and solved the new and gigantic problems which the conquest of a new continent imposed. Their clear conception, untrammeled by traditions and their cheerful, unremitting labor have built up, from a mere

fringe of agricultural colonies on the seaboard, the greatest industrial community the world has yet seen, and that in the short space of but little more than a single century.

The doing has so absorbed our energies that no one has found time for the recording. We who profit by the labors of these pioneers owe them the searching out and preserving of the records of their work.

Nearly thirty years ago, our venerable Past President John E. Sweet wrote:

> Let us hope that if the high tide of human progress is sweeping on toward a more useful education, that the day may not be far away when *he who knows what to do and how to do it* will be regarded as the equal of *him who only knows what has been done* and who did it.

and

> May the time come when we shall have a museum in which there shall be gathered the finest specimens of workmanship with the masterpieces of our great engineers.

Let us begin now. Let every man familiar with any one of our many industries search out such relics as still exist in drawings, in models, in descriptions or specifications and above all, in once used but now outclassed or outworn tools, machines and structures which represent steps in industrial progress. Let him rescue them from the oblivion of the scrapheap and notify this committee of their existence, condition and location, and explain to the present owners their educational and sentimental value. This knowledge of what is available for preservation must precede the planning of any building to house them and will largely aid in inducing cities, corporations, and individuals to proffer the financial aid necessary to build up some great National Museum of the Industrial Arts.

The movement once begun, its educational value made manifest, we shall find other museums growing up in various communities illustrating special industries like the beautiful collection of textile fabrics in Lyons, or that of the exquisite hand forged armor in the Bargello in Florence.

"Peace has its victories not less renowned than War." One of the members of our committee, Dr. Kunz, who is also chairman of the plan and scope committee for the celebration of the century of peace between England and America, has proposed such an industrial museum as the fittest expression of our pride

and joy in this achievement. The long peace and the great industrial development are coincident in time. Are they not also the effects of the same causes?

Not where and how we commence, but that we commence, is of paramount importance. Our main effort should be to preserve the landmarks of our journey to a higher civilzation and thus write in enduring materials of our own fashioning, the true history of the American people. The details of how best to do it we can confidently entrust to a generation at present completing the greatest task of engineering ever undertaken.

E. D. MEIER, *Chairman*
GEORGE F. KUNZ
AMBROSE SWASEY
GEORGE MESTA
H. G. REIST
Committee on National Museum

THE PRESENT OPPORTUNITIES AND CONSEQUENT RESPONSIBILITIES OF THE ENGINEER

By Alexander C. Humphreys, New York

President of the Society

In compliance with a custom now time-honored in The American Society of Mechanical Engineers, it falls to my lot, by reason of the honor you conferred upon me a year ago, to open this 33d Annual Meeting with the President's address.

I have selected as my text: "The Present Opportunities and Consequent Responsibilities of the Engineer."

While speaking from my own experience as an engineer, industrial manager, and president of a college of engineering, supplemented by my experiences for some years past as an officer of this Society, I shall call to my aid the past-presidents of the Society. I shall touch on a number of important moot questions, necessarily briefly, and, although I shall do my utmost to avoid misunderstanding and misinterpretation, I know in advance that in this I cannot be entirely successful. We all have had opportunities to observe the generally inconclusive results from the discussions of papers read before our engineering and other societies due to this failure to secure an agreement of minds. The chances for misunderstanding will be increased because I shall not attempt to impose upon your good nature by reading my paper at length.

Doubtless we are all prepared to agree that special qualifications, natural and acquired, must necessarily involve a commensurate responsibility to employ those qualifications in effective service. For many years past I have been deeply impressed with the particular responsibility of the engineer to the community,

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Presented at the Annual Meeting 1912, of The American Society of Mechanical Engineers.

by reason of his special qualifications. If, through his special qualifications, he is competent to render service to the community at large, that service should not be limited to his particular field of work.

My proposition then is that to-day, by reason of the present complex conditions surrounding the industries, there are offered to us as engineers opportunities for public service which are exceptional; and our responsibilities are the greater because these conditions were in part created by members of our profession. These opportunities are offered to us; if we refuse to accept them, we assume a grave responsibility. The fact that others are more than willing to take the lead in the effort to solve the problems which are threatening our well-being as a nation does not relieve us of responsibility, but rather to the contrary. If we leave it to the lawyers, theoretical economists, and others, to shape the measures of reform, then, just so far as we could have bettered the result, the reproach must rest upon us. As far as possible, the work of reform should be the result of sincere coöperation on the part of all conscientious and competent members of the body politic.

If we consider their addresses collectively, I find that there is little or nothing to be said as to the opportunities and responsibilities of the engineer which has not already been said by our past-presidents.

The education of the engineer is necessarily involved in the question of his responsibility. Some of the authors of these addresses have given expression to decided opinions on this subject of engineering education, and I have no doubt that the authors were not all in entire agreement; and yet, as I read their papers, I find that it is not difficult to harmonize the seeming differences.

Let me recall to your minds these addresses and let me quote briefly from them such parts as are more particularly applicable to my present purpose:

February 16, 1880. "The Field of Mechanical Engineering" by Alexander L. Holley, Chairman of Preliminary Meeting. Five pages only of print, but prophetic as to the future of our Society. He anticipates the late movement to broaden our field of usefulness by the appointment of sub-committees of the Committee on Meetings in the interest of certain "departments of industry." Holley says:

Mechanical Engineering underlies all Engineering. . . . In these leading departments of industry which, at first thought, the public would deem quite outside of mechanical engineering, how completely is this art incorporated with their every detail. . . . The genius that reaches the harmony of perfect construction and perfect beauty (which are interchangeable terms) in Nature's inert materials may not be loftier than that which as perfectly utilizes and governs her wild and capricious forces.

Holley advises the inclusion of several classes of membership and speaks of "the advantages of the association of business men with engineers in these societies." He also recommends the holding of meetings in different parts of the country.

Organization meeting, April 7, 1880, "On the Character of the Association, the Nature of its Work and the Methods by which that Work is to be done." Inaugural Address by Robert H. Thurston, first President.

We have often, and sometimes long, suffered from the effects of legal enactments made by ignorant legislators, influenced by personal motives and the selfish advice of scheming lobbyists. This will be corrected when business men have learned to organize and to act concertedly whenever the business of the country is liable to be affected by legislation. It is their right to be heard fully and patiently, and it is their duty to take such action as will secure for them full consideration. . . .

Ours is the duty to discover facts and to deduce laws bearing upon every application of mechanical science and art in field, workshop, school or household.

Annual Meeting, 1881. "Our Progress in Mechanical Engineering," by Robert H. Thurston, President.

We are everywhere giving up the use of that expensive and perishable material wood, and the weak and brittle minerals, and are substituting for them iron and steel. . . . Machinery speeded up, product increased, labor diminished, cost lessened and machinery given greater automatism and higher efficiency both in making ordinary goods and in adaptation to finer grades. The compressed air engine, the petroleum engine and the gas engine are all just coming forward. . . . The solar motor proposed by Ericsson, the inevitably coming motor of some far-distant epoch has, as yet, made no progress beyond the plans and experiments of the inventor. . . .

Double hulls and transverse bulkheads will make these great vessels safe even against the shock of collision with an iceberg. . . .

The navigation of the air is very possibly on the point of real advancement. . . . Thus we are apparently approaching, though still, perhaps, far from this goal, and we may barely venture to hope that the engineer who is to combine the elements of success, all of which are becoming deter-

mined, will in our own day win the fame that awaits the first successful builder of a flying-machine.

. . . . . .

But the individual must be taught, not simply *permitted* to learn as best he can. Education, directed effectively with the object of giving, in least time and at least cost, a preparation for all the duties coming to the learner, whether in daily toil or social life, is called for.

Annual Meeting, 1882. "The Mechanical Engineer, His Work and His Policy," by Robert H. Thurston, President.

Nature rarely turns a sharp corner in any of her great movements. . . . It is from us, if from any body of men, that the world should expect a complete and thoroughly satisfactory practical solution of the so-called labor problem. . . . The elements of social economy are yet to become known to our people; the most obvious principles of statesmanship are yet to be learned by our legislators, and we have still to look forward to a time when our men of business and our working people shall be fairly and respectfully considered by those who direct public policy. . . .

Such bodies as this must aid our legislative assemblies in developing a *Scheme of Industrial Organization* that shall exhibit highest possible efficiency—one that will prepare the children and youth of the country to enter upon lives of maximum usefulness, and to do the work that may be given them to do with ease and comfort while, at the same time, aiding them to attain health, happiness and content, even if not independence and wealth.

The author speaks for a "common school system of general education, which shall give all young children tuition in the three studies which are the foundation of all education, and which shall be administered under compulsory law."

Annual Meeting, 1883. President E. D. Leavitt did not deliver an address.

Annual Meeting, 1884. An address without title, by John E. Sweet, President. Contrasts and compares Mechanics with Science and Literature.

The educated portion of the world look upon a book not merely as so much paper, and printing and binding, but as the thoughtful work of the author, while the same class almost universally look upon a machine as so much wood and iron, running their minds forward to what it does, and how much it will save, and what the patent it worth, rather than backward to the brain work of its author. . . .

Gauging the value of the thing on the democratic principle of the greatest good to the greatest number, the inventors of agricultural machinery will have few rivals. . . . "May the time come when we shall have a museum in which there shall be gathered the finest specimens of workmanship with the masterpieces of our great engineers. . . . Let us hope that if the high tide of human progress is sweeping on toward a more

useful education, that the day may not be far away when he who knows what to do and how to do it will be regarded as the equal of him who only knows what has been done and who did it.

Annual Meeting, 1885. "The Mechanical Engineer, His Position and Mission," by J. F. Holloway, President.

While it is true that scientific and technical training is, and must ever be, of great advantage to the mechanical engineer, there is yet another source from which, after all, he will derive by far the most benefit, and that is—experience. Not necessarily his own experience, but the experience of others, and of all ages as well. And I know of no other way in which he can be so benefited and aided all through his life.

While none will question the value of the engineer in aiding the progress of the past, all will, I think, agree that at no time in the history of the world was he so important a factor as he is to-day. Need I ask whose triumph has contributed most to the welfare of all the world,—the generals who went over the Alps, or the Engineers who went through them? Mont Cenis and St. Gothard answer.

Annual Meeting, 1886. An address without title by Coleman Sellers, President.

I invite your consideration of a variety of topics which appear to me germane to our organization. . . .

The engineer who counts cost as nothing as compared to the result, who holds himself above the consideration of dollars and cents, has missed his vocation. . . . I am safe in saying that no profession requires a broader education than that of the mechanical engineer. He must be a physicist, a merchant, a lawyer, a chemist, and he should know how to express himself in his mother tongue and be master of the modern languages far enough to have access to the scientific publications of other countries. . . . The engineer must of necessity be a hard student; his school days never end. . . . What will fit him to enter the workshop in better condition than now, will fit him better also for any other walk in life. . . . Education which spoils a man for his work by placing him above manual labor through false pride will continue to do him harm.

The author expresses himself as dissatisfied with the primary schools of the country; they should better prepare for the study to follow.

In our schools we are cramming brains with what taxes the memory to the utmost, but which sends into our workshops boys who are themselves startled to find how little they know as compared to those who, almost ignorant of book-learning, are wise in the knowledge of things about them and skillful in the use of their hands.

The author approves of college sports which train eye and hand and strengthen muscles and develop manhood.

Books, however, are not all repositories of truth. . . . We must teach the money value of knowledge and how to determine it.

He concludes:

The American Society of Mechanical Engineers can do no better work than in devising a good system of education and compelling its introduction into our public schools. Then will those who come after us take command and lead in the industries of the world, and the products of their skill and knowledge find ready sale in all the markets of the world.

This is the man who more than any other influenced the appropriation of the E. A. Stevens endowment to establish the first college to be devoted specifically to the teaching of the science of *mechanical* engineering.

Annual Meeting, 1887. "The Engineer: His Commission and His Achievement," by George H. Babcock, President.

Quoting from Alex. L. Holley's address:

The profession of the mechanical engineer underlies all forms of engineering as well as architecture, manufactures and commerce. . . . His commission is to "subdue the earth." . . . Discovery has followed discovery in a geometrically progressing ratio. . . . There is no good reason to doubt that he will become master of the air, as he is now master of the water, and he will fly from place to place with all the certainty and safety of a bird.

Annual Meeting, 1888. President Horace See, by reason of illness, was unable to deliver his address, but it was published in the Transactions of 1889. Opens with this verse from Cowper:

"Knowledge and wisdom, far from being one,
Have oft-times no connection. Knowledge dwells
In heads replete with thoughts of other men;
Wisdom, in minds attentive to their own.
Knowledge is proud that he has learned so much,
Wisdom is humble that he knows no more."

Some contend that the American youth should occupy a higher position than that of a workman; but what is more humiliating than the spectacle of thousands of our countrymen who have no trade, who daily are compelled to beg for work as common laborers. . . . It seems to me that they (the people) would be better off in this world's goods, much better citizens, and the nation far stronger, if a greater number were reared as skilled and intelligent workmen. . . . It would be a great advantage to our youths if the common school education were modified so as to call on all of the faculties of the mind, and not rely so much on cramming the memory.

Annual Meeting, 1889. Address without title, by Henry R. Towne, President. Three topics:

a The joint excursion of American engineers to Europe the previous summer;

b The contemplated International Exhibition in 1892;

c Brief resume of affairs of Society.

We are outgrowing our industrial childhood and are rapidly approaching a point where protection, which has done so much to foster our industries, is no longer needed to the same extent as in the past, a recognition of which fact will, in the near future, enable us to enter in competition for the markets of the world on better terms than we have ever done before.

Quotes extensively from Holley's address in 1880, and then says:

Holley's prediction (as to the growth of the Society) has been fulfilled, but it devolves upon us to carry on the work and if we can, to do even better in the future than in the past.

He strongly recommends the holding of the Society's meetings "in all parts of the country."

Annual meeting, 1890. "The Engineer as a Scholar and Gentleman," by Oberlin Smith, President.

As a matter of fact, the modern Engineer, if he be worthy of the name, must be a scholar as regards many important branches of knowledge. To have become this, he must possess a trained intellect and must have been through a course, whether in college or office or shop, in which he has fulfilled the most important condition of all scholarship, *by learning how to learn*. . . . True scholarship, which consists of a general knowledge of the world at large, combined with such particular knowledge of, and experience in, their chosen vocation, as to make it a success.

This social aspect of professional work, and its great importance in furthering his success in life, not only in the way of pleasure but of profit and reputation, is too often ignored by big-brained young men who are full of scientific zeal, but who have not learned sufficient practical respect for the ways of the world.

Recommends strongly the study of commercial economics, paticularly accountancy. Also, *systematic* physical culture for strength and grace of body.

Annual Meeting, 1891. "The Evolution of American Rolling Mills," by Robert W. Hunt, President. An address of the highest value, historically and technically.

But, as has so often and so fortunately happened, the difficulties and seeming hopelessness of the situation forced a solution of the particular case, and more than that, led to an invention which was destined to revolutionize the rail industry of the country.

He referred to the work of our revered past-president, John Fritz, then chief engineer of the Cambria Iron Works.

If there were no differences of opinion and professional and commercial rivalries, we would be without progress.

Annual Meeting, 1892. "The Steam Engine in Modern Civilization," by Charles H. Loring, President. Another paper of great value, historically and technically.

The Steam Engine may be truly called the material saviour of man. . . . The steam engine is a machine which has been the prolific parent of other machines. . . .

Contemporaneous historians have but scantily drawn attention to the immense influence exerted upon modern history by the steam engine. . . . The development of the steam engine could not progress much, if any, faster than the art of boiler-making.

Annual Meeting, 1893. "The Use of Small Sizes of Anthracite Coal For Generating Steam," by Eckley B. Coxe, President. A study in considerable detail. Admirable for its practical consideration of the questions involved in the testing and valuing of coals.

What the man who pays for the coal wants to know—and he is the one for whom the profession generally works—is how much water can be evaporated for $1, with different coals. . . . I am strongly of the opinion that the time has come when it is better for those engaged in professional investigations to give to the public the result of their investigations before they have reached a final conclusion, as it tends to bring out suggestions from others, and to gather facts which will be of great value in the work in hand.

Annual Meeting, 1894. No President's address, owing to the death of President E. F. C. Davis.

Annual Meeting, 1895. "The Modern Drop Press," by C. E. Billings, President. Briefly historical and then strictly technical. Referring to "the manufacture of the then [1854-1855] celebrated Enfield rifle for the English Government, on the interchangeable system," the author says:

To America is thus due the credit of introducing the interchangeable system in the manufacture of firearms, sewing machines, watches, etc.

Annual Meeting, 1896. "The Progress in the Manufacture of Iron and Steel in America, and the Relation of the Engineer to it," by John Fritz, President.

As a beginning I will make a brief allusion to the Mechanical Engineer, showing his origin and growth, and what he has accomplished in the great

field of metallurgy, and especially in the Bessemer and other important steel-making processes.

The millwright is shown as the progenitor of the mechanical and metallurgical engineer. Referring to the engineers of the iron mills at the time the Bessemer process was introduced, he says:

> This was the graduating period for them, and no set of men ever worked more faithfully or earned their diplomas more honestly than these men did. Their diplomas were not made of parchment, but of bright ideas, hard work and energy, coupled with a determination which made failure impossible.

Annual Meeting, 1897. "The Telescope Considered Historically and Practically," by Worcester R. Warner, President. (Followed by an extended discussion by John A. Brashear.) An address of great interest along the lines shown by the title. May well be recommended for reading and re-reading from time to time to those who propose that the mathematics and sciences of the past ages should be "scrapped."

Coming to comparatively modern times, the author reminds us of "that most eminent physicist, Joseph Fraunhofer of Munich. He died in 1826 but is today quoted by the physicists and astronomers of the whole world."

Annual Meeting, 1898. Address without title (but it might well be called "The Engineer"), by Charles Wallace Hunt, President.

> Each one of us . . . as it were, looks through a colored glass which gives a personal tint to the scene, colored by the effects of our environment, as well as by our personal temperament. . . .
>
> In order that we may proceed in harmony of thought, we must use words in the same sense. . . .
>
> The new discoveries of materials, of forces, and of laws which now succeed each other so rapidly, make a corresponding increase in the range of the work and the responsibility of the engineer of this present day. . . .
>
> The engineer of the user and the engineer of the maker have widely different duties. . . .
>
> These societies thus become, so to say, the saving banks of our civilization, the repositories and guardians of the results of investigations, experiments and experience that otherwise would have been lost to the world. . . .
>
> It is this great fund of information, principally accumulated during the last century, that we draw upon for material for our text books, our general treaties, and our engineering handbooks.
>
> Man builds to master, to resist or to guide the forces of Nature. If he

has rightly judged the conditions, his work stands as a permanent monument of the fact; but if otherwise, the irresistible laws of Nature will develop the defect and discover the ignorance, incompetence or error to every observer.

Annual Meeting, 1899. "Engineering in the United States Navy. Its Personnel and Matériel," by George W. Melville, President. Largely historical.

Referring to Benjamin F. Isherwood and his work on the vessels employed in our Civil War:

He was accused of building engines which were inordinately heavy, which accusation he has never denied. To the mere office engineer this was true, but he realized what they did not, that these engines had to go into the hands of men who were largely untrained and unfamiliar with machinery. . . . To my mind this was the highest proof of his talent as a sound designer. He had the courage to invite criticism from the book-engineer in order that he might ensure success for the country.

The officers of the Navy designated as "Fighting Engineers."

Annual Meeting, 1900. "Some Landmarks in the History of the Rolling Mill," by Charles H. Morgan, President.

I have often found it to be true that the axioms of my neighbors' trade were the problems of my own, the things by daily contact trite to him, of interest to me. . . . Watt's engine *is* the Hercules, but the rolling mill *is his club*. . . . Those were curious days in the light of to-day; when the appraised value of the West was expressed at Washington in such figurative terms as "interminable desert," "arid plain," "impassable mountains," "not worth a pinch of snuff," "region of savages and wild beasts," "deserts of shifting sands, dust, cactus, and prairie dogs." And so it was, and so it would be now, but for the products of the rolling mill.

Annual Meeting, 1901. "The Early History of Open Hearth Steel Manufacture in the United States," by Samuel T. Wellman, President.

The starting of the works was attended with the usual mishaps which always attend the launching of a new enterprise, especially in the iron business.

This whole paper shows how success is won through costly experimenting and temporary failures. A valuable lesson for the young engineer; and particularly valuable today in connection with the appraisal of properties, which many incorrectly think should be appraised on the basis of original or reproductive cost, less depreciation as derived from some life table in connection with statement of age.

Annual Meeting, 1902. No address made by President Edwin Reynolds.

Annual Meeting, 1903. "The Money Value of Technical Training," by James M. Dodge, President.

This paper caused much pain to some of our friends of the schools and colleges who regard the use of the term "money value" in connection with education as indicating a sordid tendency on the part of those of us who agree with the author that "money value" is one test of efficiency.

> Up to a very recent date, the Apprentice System and that of Independent Delving represented the sole methods of acquiring training. . . . The blending of these two methods developed the earlier mechanical engineers and, will, even in the future, enable those sufficiently gifted by Nature and habit to acquire eminence. The progress of the world, however, calls for a better and more speedy means of producing trained men than could ever be developed by the methods of self-instruction. . . .
>
> We are all prone to take extreme cases of success or failure as the basis of our opinions, and lose sight of the fact that it is the average man whose career shows the true force and direction of the current.

Annual Meeting, 1904. "Some Refinements of Mechanical Science," by Ambrose Swasey, President. Closing paragraph:

> We have recounted some steps of the progress that has been made in the measurement of time, of angles and of length, together with some of the refinements in these measurements, but we are confronted with the fact that notwithstanding all that had been accomplished from centuries past down to the present time, there are, as never before, many imperfections requiring new problems in mechanical science to be worked out for the further enlightenment and welfare of mankind.

Annual Meeting, 1905. "On the Safe-Guarding of Life in Theatres: A Study from the Standpoint of the Engineer," by John R. Freeman, President. A document based upon patient, competent study. A statement of actual conditions found and of proposed remedies.

> In the course of my own studies of the theatre and auditorium problem, I have seen almost everywhere conditions affecting the safety of life that would not be tolerated by the managers of our best industrial works, and all from simple failure to know or to give attention.

Annual Meeting, 1906. "On the Art of Cutting Metals," by Frederick W. Taylor, President. An illustrated book of 248 pages, or 319 pages including the discussion, covering the result of 25 years of work, concurrent work of educated engineers and workingmen, and continuous coöperation of ten great industrial establishments, at an expense of $200,000. A rare example of persistent investigation for the development of truth.

Answering parts of the discussion, Mr. Taylor says:

Our interest in the scientific, or what one might call the intellectual element of the art of cutting metals has been, of course, very great; but after all the true measure of the value of this work should be the actual every day help which will be given by these laws to the superintendents, foremen and mechanics in our machine shops.

Annual Meeting, 1907. "The Mechanical Engineer and the Function of the Engineering Society," by F. R. Hutton, President. An exhaustive presentation of the two subjects covered in the title.

Tredgold's definition of engineering "is silent upon that group of engineers concerned with the liberation, the generation and transmission of forces which are potential and are not realized in nature until in accordance with the natural laws some engineer has caused them to appear."

The author points out that while Tredgold did not include them in the "powers of nature," today there must be included "the forces which are economic or social or psychological in their application" when "human beings become the organs and implements of the factory as a tool of production. . .

The Engineer has therefore become an economic factor as he was not conceived to be in that earlier day.

. . . . . .

Any policy or step which gives occasion rightly to charge a tendency for a national body to localize, is an invasion of opportunity and value.

The author considers at length and favorably the reasons for encouraging local meetings of sections of the Society. Such sections may be either territorially grouped, or by topics and common interests."

Is the privilege of service and of function all on one side or has the Society the right to ask from its members a reciprocal duty to itself? The latter, no doubt.

Annual Meeting, 1908. "The Conservation Idea as applied to The American Society of Mechanical Engineers," by M. L. Holman, President.

The author uses as his text the Conservation Congress held in 1908 at the White House, presided over by the President of the United States and attended by the Governors of States and representatives of engineering and other organizations. An admirable example of the engineer as a citizen employing his special knowledge for the instruction of the community.

During the discussions it became apparent that some effort would be required to keep the conference from political bias. . . .

The President particularly desired the coöperation in the movement of the engineers of the United States and subsequently ascribed to the action of the Engineering Societies the credit of inaugurating the conservation campaign on non-political lines. . . .

As new parties are developed the chances of government by the minority become greater, and with a sufficient number of political parties in the field, revolutions will be the order of the day. . . .

One city for years discharged its sewage into the margin of a lake and took its water supply from the same place. . . .

With us, however, civil and religious liberty seems to include unnecessary exposure to disease. At the conference in Washington, the preventable disease problem was practically overlooked, perhaps from the fact that no trust seems to be operating in that field. . . .

I venture to suggest that we might make progress by ascertaining the secret of German frugality and prosperity rather than by compiling masses of figures to prove what is well known, viz.: that we are wasting the resources of Nature like a true prodigal son. . . .

Which one of you, as householder or engineer, will put up with a poor run of coal in order that posterity may have a good coal? The departments of our government demand the best grade and are not willing to take the "run of the mine."

There is, at present, a strong tendency towards bureaucratic development that is inimical to the successful continuity of our form of government. . . .

Concludes: The Engineering Societies must fall in with the conservation idea and see to it that the returns from the Societies are commensurate with the efforts expended in operating them.

Annual Meeting, 1909. "The Profession of Engineering," by Jesse M. Smith, President. First historical and then largely a consideration of Society activities and the interrelationship of the several engineering societies.

The Engineer capable of being at the head of the larger engineering works must know something of many things, several things well and one thing profoundly.

Concludes: The American Society of Mechanical Engineers has before it a future of usefulness to its members and influence in the profession, which is unlimited. It only requires that we stand by our tradition of increasing the membership with men of high quality as Engineers; that the members maintain enthusiastic devotion to good professional work; that they cooperate with each other in the broadest and most friendly spirit to produce that solidarity of membership and devotion to high ideals, which will compel the world to class the profession of Engineering with the other learned professions.

Annual Meeting, 1910. Address without title, by George Westinghouse, President.

After a brief reference to the affairs of the Society, and particularly to the Joint Meeting at Birmingham, England, with the Institution of Mechanical Engineers, and a brief discussion of "the standardization of mechanical devices," in compliance with suggestions made to him, the author devotes the remainder of his address to an "authoritative statement for the records of the Society" of "my work in developing the airbrake." A valuable record of a great work.

Annual Meeting, 1911. "The Engineer and the Future," by E. D. Meier, President.

A century ago the distinction between the civil and military engineer sufficed, but a few decades ago it became necessary to differentiate in turn the mechanical and electrical engineer, while quite recently upwards of a hundred specialties were enumerated in the attempt to define the activities of the profession, each of which has its recognized experts. . . .

Speaking of men of science: It is the duty, the glorious privilege of the Engineer to receive their discoveries with reverent hands, and apply them to the solution of the practical problems of life. . . .

The Engineer then is a devout believer in natural laws. He knows that they are immutable and permit no exceptions. He needs no Supreme Court to define them as reasonable. . . .

The Engineer is responsible for the vast increase in appliances to meet every demand of that most voracious of living beings, man. The mass of mankind needs to be educated to understand and use them properly. He is in honor bound to supply this education.

As we read these papers continuously, we must be impressed with the wide scope of our professional responsibility, and we, more particularly as mechanical engineers, must be impressed with the point so strongly made in the address of Holley, and referred to by many of his successors, that mechanical engineering underlies all engineering. But here it is well for us to keep in mind that all engineering, while differentiating in great variety as to details, necessarily must be considered comprehensively in the planning of nearly all important undertakings.

The words of our past-presidents serve continually to remind us that the responsible engineer must be a completely qualified expert in some one branch of engineering while possessing a broad grasp on engineering activities as a whole, including the ethical and sociological elements of industrial administration.

Especially for the benefit of students in engineering, I suggest that these addresses be gathered together in a separate volume. A thoughtful reading of these papers should serve to

teach these students that the profession they are preparing to enter is committed to public service along broad lines of usefulness. I further suggest, in future lists of past-presidents that Alexander L. Holley's name be included as the Chairman of the preliminary meeting for organization. We may readily believe that he would have been elected to the office of President if he had not been on the first nominating committee, and if it had not been for his untimely death less than two years after the Society was organized.

As we look over the actual record of progress since the writing of the earlier of these papers, we find that the growth and improvement in material things in many cases has surpassed the prophecies of the writers; but in educational and sociological questions, and particularly as to the relations between capital and labor, so-called, I fear the hopes expressed have not been realized. Here then are the opportunities for the men who, if they will, can speak with authority.

In one other particular we must be strongly impressed by the reading of these papers—the great educational value of the study of the history of engineering. To the engineer-student and the young engineer especially, this study is of great value both specifically and culturally. It is a branch of our educational work more or less neglected in many of our colleges of engineering. Those of us who came more directly in contact with Mr. Conrad Matchoss, the representative of the Munich Museum, during his recent visit to the United States, must have realized that here we have opportunities for progress. And intimately connected with this teaching of the history of engineering is the need for the establishment of at least one comprehensive museum, illustrative of industrial progress, organized somewhat along the lines of the Munich Museum. Let us hope that there may be found, and soon found, those willing and able to father such a scheme. It is a hopeful sign that several of the national engineering societies and other interests are preparing to coöperate for the solving of this problem.

The question of the responsibility of the engineer must carry back to those who are responsible for his education and specific training: including not only the colleges of engineering, but also the graded schools and the employers and others in control of those employed.

With regard to the schools in which our boys are prepared for the engineering college or for a direct entry into business or industrial life, may we not charge that these schools are not as a rule conducted for the benefit of the masses? May we not claim that the public schools, supported by taxation, should be administered primarily for the preparing of the masses for self-support? The keynote in our scheme of public education should be thoroughness, and particularly with regard to the three Rs and the elementary studies in general. The course of instruction in our public schools should be shaped for the benefit of those who are *not* to enter college; that is, for those who, by one cause or another, are forced to become wage-earners at eighteen years of age *or less*. In the scheme, adequate provision should be made for those who do not and cannot remain in school beyond the grammar school period. This change would not work an injustice to those who find themselves in a position to continue their book- and laboratory-study in the colleges. The present scheme tends strongly towards superficiality, which must be harmful to all.

In the case of those who are preparing to enter the college of engineering, I hold that they should not be subjected to a specialized preparatory training. I hold that these boys particularly should receive a sound general training, for they are the ones who will obtain later the advantages of the specialized training. The high-school pupils who are not to enter the college of engineering are the ones more in need of instruction in mechanical drawing, manual training, and the like. If, in the allotted time, the boys preparing for the college of engineering could get a sound preparation in the general studies and also get the preliminary practical training, so much the better. But the crowded curriculum of the present day tends to prevent this. *To secure thoroughness our public schools must reduce their requirements or increase their efficiency, or both.* And in this connection it must be realized that all culture is not obtained from so-called cultural studies.

Of late years we hear much to the effect that, by reason of the rapid strides made and being made in engineering science, the courses in our colleges of engineering should be extended from four years to five, six, and even seven years. Included in this scheme of extension is the purpose to devote a considerable

portion of the college course to the general or non-technical studies. If this is wise, then why not use the years of preparation most advantageously on the general studies? In the case of the boy preparing for the college of engineering, why begin to specialize before he enters college? The case of the boy who is to go out from the grammar school or high school to become a wage-earner is quite different. We might, if it is practicable, specialize in his case. And here the coöperative system, the alternating of school and shop, or school and business, demands our thoughtful and sympathetic consideration. This same system, carried on a higher plane, is particularly worthy of our professional attention, especially as now being tried so intelligently under Dean Schneider, of the College of Engineering of the University of Cincinnati. In any case, in the four years engineering course, the general studies should not be slighted and the technical studies should be so presented and taught as to give them the greatest possible cultural value.

For the great majority of students, I cannot believe that it is the part of wisdom to extend the college engineering course beyond the four years which is now the general rule. For these men the age of graduation, on the average, is about twenty-two years. At that age a young man intended for our profession certainly should be prepared to earn a living; continuing, however, to be a student, as he must continue to be to his last active day in his profession, if he aims to fill a position of authority.

If the college course is to be extended by reason of the many more things now to be learned, will five, six, seven, ten, or even twenty years be sufficient? My answer is in the negative, and for two reasons. No matter how many years the student remained in college there would be more to learn of engineering science; and much that the engineer needs to know, the college or university cannot teach. But in four years the college of engineering should be able to teach its students, if they have the natural qualifications and have been soundly prepared, how to learn by themselves, and so how to profit effectively by the teachings of experience. Is there not some measure of disadvantage in keeping an engineering student engaged exclusively on the study of theory, even if the theory is presented in as practical form as is possible in the class-room and laboratory? Is it not true that those who employ young engineers who have had only four

years of college environment complain that too many of them are at first more or less disqualified for practical work by having too high an appreciation of, and too great a reliance upon, their college training? The longer they stay in college, the more apparent will be this partial disqualification.

I know that I shall here be misunderstood to the effect that I am arguing against college training for the engineer. Nothing could be farther from the truth. I am arguing in favor of a proper balance between the teaching of the college and the teaching of the school of experience; that is, a proper balance between theory and practice.

Also, I am not arguing against post-graduate courses for the few who may be specially qualified for advanced study in theory and research. Though here I believe that many engage in college post-graduate study who would do better out in the field of practice. A man is not temperamentally qualified for research simply because he thinks he is. The best graduate school for the great majority of engineer graduates is the school of experience. In many cases even research can be more advantageously pursued outside the environment of the college, in direct contact with the conditions governing practice. This is shown in the many instances of the fruits of outside research carried back into the college and there taught to the undergraduates, giving them the data so disclosed and helping to impress upon them the value of and necessity for experience teaching. Why is it, in the face of these facts continually presented to the college instructors, that certain of them are so ready to claim a monopoly of all educational agencies?

It can be claimed that the store of experience teaching thus carried back to the college can there best be classified and standardized. To a large extent this is true. But here, as in every other such question, there are two sides to be considered. Not always is the schoolman qualified to interpret correctly and comprehensively the data thus placed in his hands. Here is where our engineering societies are doing an important work outside of the colleges, as well as in coöperation with them and their professors as individuals. In the cause of increased efficiency this all speaks for coöperation, and particularly for an adequate appreciation of the value of coöperation between schoolmen and practising engineers. To this end the professors

of engineering should be encouraged to engage in practice for their own benefit and for the benefit of their students. This coöperation can be further developed by direct interchange of ideas and data between professors and their *former students*, as practised in some measure in this country, and to a much greater extent, I understand, in some of the German universities.

Are not many of our troubles with respect to education occasioned by the belief on the part of many educators that all education is to be obtained only within the school and college walls? If they do not believe this, do not many of them minimize the educational value of experience in the business world in contact and competition with one's fellows? Having in mind some of the men with whom we are constantly associating, it seems absurd to have to remind ourselves that the school of experience teaches many things which the school and college cannot teach, and that this school of experience also may exert a strong cultural influence.

Even if some of the schoolmen are inclined to underestimate the educational value of experience teaching, we as engineers must not forget, before the first college of engineering was organized, that the engineer was busy at his many tasks, and the mechanical engineer had produced the steam engine,—that most potent progress-maker of the ages.

While referring to experience teaching and the insufficiency of the unsupported college training for the engineer, permit me to give a word of advice to the juniors of our profession. Too frequently young engineer graduates assume the responsibility of acting as consulting engineers before they have had adequate practical experience. A few make the more serious mistake of assuming this great responsibility immediately after graduation, before they have had any practice. The engineer graduate is not an engineer until he is qualified to deal with the practical conditions of his selected specialty. He must be a commercial engineer in the sense that he should regard the money, for the investment of which he is more or less responsible, as a sacred trust. It is not for him to risk his employer's money in experiments for which he is not qualified by specific experience.

Still more unfortunately some of these young men set up as general consulting engineers. The saving clause is that they are probably as competent in one engineering specialty as another.

No man should attempt the role of consulting engineer until he has had a comprehensive and practical experience in his specialty. By doing so the offender brings discredit not only upon himself but upon our profession as a whole.

Having said this to the young graduate, permit me to say a word as to the responsibility of his employer. The young graduate should not be left without guidance in the school of experience. If the employer is an engineer or is competent to direct in the practical things of his specialty, he should see to it that the employee gets every possible opportunity to learn the practical side of the business and to harmonize the theoretical with the practical. Too often the cadet engineer will be difficult to teach and direct because of his unreadiness to believe that he needs this practical experience. Too often he is unwilling to get down to the long hours, dirt, and drudgery which may be required to win this practical experience. It is the duty of the employer to provide the means for this, and, failing in success after a fair, patient, and intelligent trial, to assist the youngster to a better understanding of what is required of the engineer by giving him his discharge. I know of a number of good men who have been saved by this seemingly severe treatment.

In the treatment of the cadet engineer there rests upon the employer a grave responsibilty. Many a young fellow has been unfairly treated because through ignorance, indifference, or stupidity the one in authority has expected more than could in reason be demanded. Some employers, not technical graduates themselves, exaggerate the immediate results to be obtained from a college training. Others, college graduates themselves, forget how little they knew of practical things when they graduated, and they think they are comparing the ignorance of the cadet with what they knew when they graduated; whereas, really they are comparing with what they know now after ten, twenty, or thirty years of practical experience.

Other cadets have the misfortune to fall under the control of so-called "practical men" who despise "book-learning" and are glad of an opportunity to expose the ignorance of the "college boy." It is the duty of the employer, especially if he is an engineer, to see that the young graduates taken into his employ are, as far as possible, saved from these harmful influences, including the conceit of the graduate himself, which work injury to both employer and employed.

From all that I have said as to the opportunities for improvement, let it not be understood that I am condemning the combination of educational agencies which has produced the men who have done so much for this country through its industries. We must realize that the passage of time has wrought of late great changes, not only as to the science of engineering, but in a marked degree as to the sociologic and economic conditions within which we must practice, if we are to meet our responsibilities to both capital and labor. A system which *permits* men of more than average ability or determination to qualify for our profession should be so improved through experience teaching as to enable us to turn out from our educational mills a larger percentage of first-class product and to reduce the percentage of rejections. Many a young man who might have given a good account of himself, if he had been better handled at some turning point in his career in college or practice, has failed because he had not yet developed the stamina to resist the forces, negative and positive, which were opposing his progress. It is a source of gratification to me that I have saved some from breaking under the strain of injustice in the college and in the school of experience; and it is a source of regret and humiliation to me that in certain cases, as I can now realize, I failed in my duty in this respect.

In arguing for saner and better balanced educational methods to meet the conditions referred to, conditions of the past as well as of the present, I have no sympathy with those who condemn all our educational theories and methods as obsolete and therefore to be consigned to the scrap heap. Some English engineer, whose name I have forgotten, said that where the United States engineers and industrial managers had a distinct advantage over his countrymen was in their readiness to scrap obsolete apparatus. This "scrapping" process can be, like everything else, carried to extremes. We should first determine whether by new combinations the apparently obsolete apparatus or machinery cannot again be made commercially efficient. The inefficient elements only should be replaced. And when it comes to the question of scrapping plant, we must determine whether the interest on both the old and the new does not absorb the anticipated savings. I do not hesitate to affirm that in this country, in our enthusiasm for improvement, we have frequently been guilty of wasteful practice in this regard. This, in a marked degree, ap-

plies to much that has been proposed in connection with the scrapping of our educational agencies.

In connection with discussions of industrial questions and the education of the engineer, we hear much of the opportunities for increased efficiency. There are such opportunities and there always will be. But we also hear much of conservation, frequently from the same sources. Efficiency of methods should include true conservation; the elimination of the false and defective, but certainly the retention of all that has been proved through experience to be true and useful. With Patrick Henry I say, "I know of no way of judging of the future but by the past." Many of our modern reformers would change this to read, "I know of no way of planning for the future but by disregarding the past."

With the conserving of the good and useful there should be the constant effort to render these still more useful. The older a method or practice, provided it has stood successfully the test of years, the more it is to be prized. Yet we are told by some reformers, because a thing is old, and for that reason alone, that it should be scrapped. We are told, because of the marvelous progress made in engineering science in late years, that all the teachings of our schools of engineering should be scrapped. We are told that practically all that was taught in these schools twenty-five years ago is now obsolete. Have all the teaching of languages, logic, history, mathematics, physics, and chemistry of the past been rendered valueless because we have advanced in our knowledge of Nature's laws? Apart from more direct arguments, we may say that one of the most valuable lines of instruction for the study of engineering is the history of the development of engineering science. If it is true that all this of the past is valueless, how was it that the men of the past, taught in the schools and outside of the schools, were able to produce these wonderful advances?

What is the specific function of the college of engineering? Is it to store the brain with facts, or what the teachers believe at the time to be facts, or is it to train and discipline the brains of the students to think with facility and accuracy along the lines of their future vocations? Many of us who, for the time, have forgotten much of this store of facts without being seriously embarrassed by the loss, have our answer to this question. Again

let me say that the school and the college cannot complete the training of the engineer; and that these agencies can only prepare the student to learn his profession in the field of practice. Given the personality, it remains for him to develop in the field of practice the initiative for which the formal teaching and drill of the school and college should have prepared him effectively. Included in this preparation should be some teaching of the business side of engineering practice, including the principles of such subjects as accountancy, depreciation, commercial law, patent law, specifications, contracts, and analysis of data.

Whatever may be said as to the room for improvements in the agencies, processes, and methods employed in the education of the engineer, it should need no argument to demonstrate that the leaders in the profession are as a class those best qualified to advise authoritatively in connection with the efforts to solve many of the most serious problems of the day, involved as these are with questions of transportation, public utilities, and the industries in general. And for the well-being of our country these problems must be solved wisely.

This is an age of reform, and of late years reforms have been so hastily and incompetently put forward as to bring the term reform into reproach. In fact, a significant feature of many of our reform movements is the readiness of the leaders to act on impulse and without anything approaching adequate investigation. As has been well said, it seems to be a characteristic of this class of reformers to go too far and too fast.

It is with deep regret that I express the belief that college professors, especially professors of economics, and even ministers of the gospel have frequently been offenders in this regard. I believe that certain professors are being retained in their chairs who should be displaced. Especially in the case of universities this may be due to a tendency on the part of president and trustees to exaggerate the right of free speech. Certainly a professor in a State university, to say nothing of the endowed universities, should not be permitted to teach doctrines subversive of law and order and the rights of the individual and property under the Constitution. If these men cannot be controlled by those to whom they are immediately responsible, they should be controlled by those who control the universities.

It is to be borne in mind constantly that good intentions do

not qualify one to do expert work, whether that work be in connection with some reform measure or in some other line of public activity. Here is to be found a grave error of which many an honest enthusiast is guilty. The more astute and sordid of the politicians welcome the assistance which they can secure by guiding the enthusiastic and hysterical reformers into lines of activity which will offer opportunities for trading in immunity, obtaining fees for lobbying, or securing remunerative employment as the agents of these enthusiasts.

Righteous indignation is to be welcomed, and we had better start out in our reforms with the conviction that *as long as the world exists* there will be full opportunity for righteous indignation. But righteous indignation does not of itself provide a remedy for the evils at which we rebel; it only supplies the desire, and possibly the purpose, to produce a remedy. Righteous indignation and misdirected zeal may produce conditions practically as bad as those which it was purposed to correct or eliminate. Reform should not depend upon hysterical suggestion and fitful support, but should be actuated and maintained by all the forces suggested by experience; it should be constantly and tenaciously, but not vindictively, pursued, acting along the best lines suggested by competent, sane, impartial investigation.

As one of the forces to be reckoned with, and particularly in the industries in which our profession is so vitally interested and for which we must carry such a burden of responsibility, is the tremendous force of ignorance and prejudice constantly being swept in upon us by the tide of immigration. If we hold that our country is to be a haven for the ignorant and oppressed, it is then our duty to provide for the control of the elements of danger we so accept. If we offer a haven to these people so ignorant of our fundamental laws for the protection of life and property, certainly we have the right and it is our duty to demand that at least they shall be subject to those laws. The laws as they stand must bind them as they bind us until amended according to law.

The record of recent happenings shows us that there are very real dangers to be apprehended from this source. We need only to read the reports of the trial at Indianapolis of the men of influence under indictment for dynamite outrages, the record of the Los Angeles dynamite outrage so closely linked with

this Indianapolis trial, the trial recently ended at Lawrence of men of like influence indicted for murder through suggestion, the trial of the man who attempted recently to kill an ex-president of the United States, the trials of members of the police force and gangsters of this city, and many other like events indicating a confidently bold disregard for the rights and the very lives of those opposed to these enemies of law and order, to convince us that popular government is under trial as it never has been before in our history as a people.

As I have before suggested, the danger does not lie alone with the ignorant and the designing; if that were true, the danger might be met with greater confidence. But we have to see that the enthusiasm of honest but misguided reformers has to be reckoned with; and these people are to be found in our schools, colleges, universities, industrial establishments, and counting houses.

Let me quote the words of Schrank who tried recently to assassinate Ex-President Roosevelt:

> The shot in Milwaukee, which created an echo in all parts of the world, was not a shot at an Ex-President, not a shot at the candidate of a so-called Progressive party, not a shot to influence the pending election, not a shot to gain for me notoriety; no, it was simply to once and forever establish the fact that any man who hereafter aspires to a third presidential term will do so at the risk of his life. If I cannot defend tradition, if I cannot defend the country in case of war, you may as well send every patriot to prison.

This is high-sounding and has a truly familiar ring. Two of the men on trial at Lawrence made statements which also indicated that they considered themselves champions of the defenceless and apostles of liberty rather than of anarchy. These appeals to unreason have a strong influence upon those who are at once ignorant and highly emotional. Unfortunately, those who cannot be charged with ignorance in the ordinary sense are led astray by these hysterical appeals to unreason because they appear to reflect a worthy motive.

And yet this man Schrank, who considers himself a hero and martyr, and who is able to put his dangerous views thus plainly and strikingly before us, by the unanimous verdict of a number of competent physicians, has been declared to be a homicidal maniac.

With the conditions at present surrounding us, which I have

barely suggested, is it not of the first importance that our public school system should be kept free from teachings which are dangerous to our commonwealth? Should not the system go farther and exercise a positive influence for sane thinking upon the children under its influence during the most impressionable period of their lives? Not only should these pupils be taught directly respect for the rights of others and respect for constitutional government, but, above all, the aims and methods should be so amended that the thought constantly kept in the minds of teachers and pupils shall be that the pupils are being trained to become self-supporting and so self-respecting units of the body politic. This implies that these boys and girls shall be taught, shall have pressed home upon them constantly, directly and indirectly, that labor of the hands as well as of the brain, if conscientiously performed, is honorable. Undoubtedly, there are many schools in the land where high-minded, sane teachers are doing their best so to influence their pupils. Of this my talks with many of them convince me; but I have been at the same time convinced that most of these faithful servants of the people feel that they are working under the disadvantages of a system which too generally fails to dignify the labor required for self-support and to cultivate pride in all work well performed.

A respect for law and order should be inculcated in our public schools by the maintenance of a more intelligent and more exacting discipline. The State has a right to demand and should demand, if a free education is provided for the youth of the country, that those so benefited shall render prompt and exact obedience to those in authority. In many cases politics comes in to fetter those who are in immediate authority, and this to the great injury of the pupil, the teacher, and the community. Many men and women, now parasites upon society or criminals, would be self-respecting members of the community if they had been trained to respect honest labor and at least directed to, and given a fundamental preparation for, some vocation.

Let the public schools be conducted for the benefit of the masses and not for the benefit of the very few. The many can be provided for readily and effectively without sacrificing or even hindering those who are qualified by natural endowment to enter college. If some who now go to college were discouraged from so doing, it would be no loss to them or to the community.

Upon us as members of the profession of engineering, individually and collectively, rests the responsibility for doing our utmost to check and correct the evils which I have thus inadequately brought back to your attention. Collectively, and particularly as members of this Society, we are responsible because some members of our profession have been at fault as the advocates of hasty and ill-considered measures of so-called reform. Reforms, especially in connection with industrial administration and the relations between capital and labor, which might be inaugurated by our Society or its members after full and candid discussion, should be of decided benefit to the community as well as to our profession.

Certainly in the matters connected with public education our profession should be able to advise and direct, for the members of the profession have unsurpassed opportunities to judge of the effectiveness of the work of the schools by the results as evidenced in the product. I am quite aware that some professional educators will not be slow to charge that the engineer is not an expert in the field of education, but to this we may reply that this is not solely an academic question and the results are showing every day that the educators need the coöperation of all who are qualified to assist. And may we not claim that the members of our profession as a class are brought as close to the hearts of the people as are the workers in any other one vocation?

Here is another opportunity for unselfish, open-minded coöperation, which is so much needed in our country today.

Now let us for a moment review the work of our Society during the year just closing. The record will be placed before you in detail, but I wish to meet the question, Are we progressing? Are we, in some fair measure, meeting our responsibilities?

In membership we have made a net increase from 4007 to 4350, not counting the affiliates of the Gas Power Section, which show a net decrease of 8, and the student affiliates, which show an increase of from 635 to 722. It is of interest here to note that since Past-President Jesse M. Smith made his presidential address in 1909, the membership of the four national societies generally considered together, civil, mining, mechanical and electrical, has increased from 19,000 to 22,800. The many other engineering societies, specialized and local, no doubt would bring the combined membership up to not less than 50,000.

Our Society may look for a much larger increase in membership during the coming year, as a result of the earnest and intelligent work of the Committee on Increase of Membership under the able and enthusiastic direction of Past-Manager I. E. Moultrop. If the proposed amendments are approved, the additional grade of Associate-Member should serve to bring into our Society a considerable number of men capable of broadening our sphere of usefulness. Not only should we do our utmost to interest as large a proportion of the membership in our activities, but we should do all that is proper to bring into our Society those who are eligible under any of the several classes of membership and who are willing to aid in our work, remembering that membership in such a society as this means giving as well as receiving. This broadening of scope of membership is, as I have already shown, in accord with the suggestion made by Alex. L. Holley at the preliminary meeting in 1880.

Chiefly to the work of the Committee on Increase of Membership and the Gas Power Section may be credited the $10,000 received this year from initiation fees and $20,000 added to our annual income. This activity has materially helped us financially, so that after meeting our pledge to pay off our land bonds, at the rate of $6000 a year, we have added $4000 to our surplus.

Under the able direction of our Publication Committee and the staff, not only has The Journal reflected great credit upon all concerned, but it has contributed a net surplus of $2000 to our treasury. This can be compared with an annual deficit of about $10,000 earlier in our history.

The excellent showing with regard to our finances in general is in large measure due to the supervision of the Finance Committee under the untiring and devoted direction of the Chairman, R. M. Dixon.

Mention is due for the most efficient management of the United Engineering Library under the committee, librarian and staff. This library is performing a service to the engineering profession which is not equalled in our country and of which the three responsible societies may well be proud.

A Society such as ours, if it is to grow in usefulness and influence, must not depend upon the activities of the officers and committees, no matter how devoted and self-sacrificing. The policy of the Society should be to engage the membership at large

in its activities to the greatest degree possible. With this reflection in mind it is most gratifying to note that we have made decided progress during the year in organizing additional geographical groups, and in making some progress towards the development of a simple scheme of administration therefor which shall provide as large a measure of home rule as is consistent with our constitutional requirements.

Also, during the year most satisfactory progress has been made in organizing sub-committees of the Committee on Meetings under the chairmanship of Dr. C. E. Lucke. There has been suggested forty sub-committees to cover as many phases of mechanical engineering as found in the industries of the country. Believing it is wiser to make haste slowly, the full number of these committees has not yet been appointed. The following have been appointed and have organized: Textiles, Administration, Cement Manufacture, Iron and Steel, Air Machinery, Railroads, Hoisting and Conveying, Industrial Building, Fire Protection, Machine Shop Practice.

The work of these sub-committees may be expected to extend materially the usefulness and influence of our Society. The other sub-committees as suggested should be organized just as soon as a sufficient number of specialists can be interested and the money can be found.

Primarily, I believe, due to the initiative of our Secretary, Calvin W. Rice, the engineers of America and Great Britain have coöperated to erect a memorial window in Westminster Abbey to Lord Kelvin. Members of our Society participated liberally in this tribute to a great man and a great scientist.

Your Council has accepted an invitation to participate in a meeting of the Society of German Engineers to be held in Leipzig next summer. It is to be hoped that our members will evidence their appreciation of the attractive program, which our hosts have prepared, by attending in large numbers.

It is proposed that in connection with the San Francisco Exposition in 1915 there shall be an International Congress of Engineering. In concert with the Society of Civil Engineers, the Institute of Mining Engineers, the Institute of Electrical Engineers, the Marine Engineers and Naval Architects, your Council has already taken preliminary action favorable to this undertaking.

A number of most important committee reports, covering technical subjects of vital interest, will be presented during our meeting. Special reference may be made to a notable report prepared by Mr. Geo. A. Barrus as a member of the Committee on Power Tests.

To provide for the whole of the rich program prepared by the Committee on Meetings, our professional sessions will have to be divided into a number of sections.

Even this brief and fragmentary reference to the work of the year serves to show that the Society, acting through its officers, standing committees, special committees, and the staff, has been maintaining its reputation for effective service and has been reaching out into other fields of usefulness. It is for the members at large to appreciate the service thus rendered and to be prompt to do their share by accepting the opportunities for service offered by membership on the committees, present and prospective.

Thus at considerable length, and yet inadequately, I have discussed the opportunities and consequent responsibilities of the engineer of today. If we claim, as we should, to be members of a profession, we must accept the responsibilities involved. We cannot claim that our profession is one of the three learned professions, because the ignorance of the past created a limitation in favor of religion, law, and medicine. But we can claim that though much of that which the engineer must have at his command is not to be learned from books, it by no means follows that his education is therefore less "liberal" than that of the minister, lawyer, or physician.

There appears to have been a tendency, not so apparent at present, to deny to the mechanical engineer the professional position more readily conceded to the civil or mining engineer. This seems unreasonable and indefensible when we study the question and are forced to endorse Holley's claim that mechanical engineering underlies all engineering. The reason for this rather intangible discrimination is in part due, I believe, to the fact that so many of the rank and file of our branch of engineering are engaged in working out the details, more or less important, of undertakings which are under the general direction of civil or mining engineers or others not members of our profession. Many mechanical engineers thus become absorbed in

the invention and development of mechanical devices, possibly of vital importance in the general scheme, and so fail to obtain a grasp on the undertaking as a whole.

The question of precedence need not be raised; there is credit enough for all. As engineers we are committed to the doctrine of efficiency. Efficiency must come from coöperation, not from discussions as to precedence and relative dignity.

Watt's steam engine made Cort's rolling mill possible. Cort's rolling mill opened up to Watt's engine a new sphere of usefulness.

The Panama Canal, under the direction of thoroughly capable engineers, was a failure until the bacteriologist, the physician, and the sanitarian made it possible for white men to live in the fever stricken zone. Now, while under the general direction and control of military and civil engineers, the success of the undertaking largely depends upon the mechanical and electrical engineers.

Then, while confidently asserting our claim to membership among the liberal professions, and accepting to the full the responsibilities which are thereby involved, let us be prompt to recognize that the progress of the world, material and ethical, depends upon the unselfish, intelligent, and devoted coöperation in service of all professions and vocations under the leadership of men of vision, intellect, power, and humanity.

DEVELOPMENTS IN MACHINE SHOP PRACTICE DURING THE LAST DECADE

REPORT OF SUB-COMMITTEE ON MACHINE SHOP PRACTICE

In this report the principal improvements in machine shop practice developed approximately during the last ten years are reviewed. The reason for presenting an extended review now, is that the sub-committee on machine shop practice should record the advances made each year, but in the present case the committee having been only recently organized, there exists in the Society's proceedings no consecutive account of progress. To carry the record back to a logical date, that of the report made by Fred J. Miller to the Bureau of the Census, in 1905, is mentioned but, of course, the actual date is somewhat indefinite.

2 The review is incomplete because of the limitation of time to prepare it, and because of a natural diversity of opinion as to the limitations of what should properly be considered machine shop practice. If this review has included matters generally regarded outside of the limitations, it may be considered that the larger field was included because of practical difficulties in drawing a well-defined line between machine shop practice as such and machine design, administration, heat treatment of steel and other factors affecting production. To ignore them is impossible. The operation of metal-working tools and their productive capacity are as much matters of machine design, arrangement and management as of individual skill. In fact, productive capacity in the past depended very largely on the skill and initiative of the workman, but now the rate of production in many branches of manufacture is almost entirely governed by the construction of machines, so that the designer, when viewed in this light, is closely allied with shop practice.

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"The transference of skill" by the machine designer from the operators to the machines has embodied in the latter much of the accumulated experience of many mechanics working on simpler and more primitive tools. So it may be asserted that much of the improvement in machine shop practice has appeared in the improvement of machine tools themselves in one way or another.

3 *Variety of Machine Shop Practice.* When it is considered that machine shop practice embraces a very wide variety of work, ranging from the smallest to the largest manufactured products, and all kinds of repair work, the difficulty of classifying and differentiating it can be appreciated. Locomotive repair work, for example, is in a class by itself in which peculiar methods have been developed, differing radically from those followed in doing similar work in other lines. The slotter, for example, is a machine tool in high favor in railroad shops and, outside of shipyards, has been little used elsewhere. It is, however, slowly coming into use in manufacturing works. The milling machine until a few years ago had not gained a foothold in railroad repair shops, largely because it was and still is not as well adapted to handle the general run of plane finishing required in these shops as the planer and shaper. The latter are adaptable machines peculiarly suited to non-repetitive operations, while the milling machine excels in manufacturing.

4 *Increased Weight of Machines.* One of the noticeable changes in machine shop equipment during the past ten years, is the increased weight and power of machine tools, which was made necessary through the general application of high-speed steel cutting tools. While the increased capacity of machines which followed in the wake of the application of high-speed steel was directly instrumental in bringing about such increases in the weight of machines, the result has been beneficial, not only in increased production but in accuracy of product, because of greater rigidity and consequent better preservation of alignment.

5 *Foundations.* Progress has also been made in the methods of erecting machinery. With large size machines the foundation plays a most important part in the accuracy of the work produced. For instance, the provision of a massive, well-built foundation for large planers is imperative. When not provided,

the weight of the machine and work must inevitably cause settling and springing out of shape. Every mechanic knows that such a disturbance of the foundation affects the alignment, which means that the work produced on the planer will be inaccurate; the use of leveling plates under the feet of planers to provide uniform support and means for correcting errors of alignment has become general; the elimination of defective action due to want of support, and the increased mass and rigidity have in the case of planers resulted in the production of plane surfaces closely approaching theoretical planes when the work itself affords the necessary rigidity and uniformity of section. Hence, hand scraping to perfect alignment is not as necessary as it was a few years ago, and it may be said that on some classes of work scraping is now largely more of an ornamental than a corrective process. On high grade machines, however, scraping or grinding probably will continue to be necessary to correct inaccuracies of surface and alignment.

6 *Electric Motor Drive.* The subject of electric motor drives was given much prominence in discussions of machine shop practice a few years ago, the bias being generally in favor of individual motor drive. While subsequent experience has shown, that the direct-connected electric motor has certain limitations and disadvantages for some classes of work, it has also shown that the same results and efficiency cannot be obtained with the group system of driving modern designs of machine tools. The investment in motors is less with the group system but the flexibility of the independent drive is lost. When a machine driven by an independent motor is properly equipped for easy handling, increase of production over that of the same machine in a group system is practically insured. One machine tool builder has found it a good rule to apply independent motors wherever the power requirement is 5 hp. or more. Hardened steel gears in the driving train reduce gear troubles to a minimum. When the character of work is constantly changing and new groupings of machines are required from time to time, the individual drive is at great advantage. The machines can then be placed "like men on a checker board."

7 Improvements have been made in the characteristics of variable speed and reversible motors. Automatic controllers have been introduced which make the stopping and starting of

machines simply the matter of pushing a button. These devices protect the motors, save time and protect the machines from shocks.

8 *Automatic Machines.* Progress has been made in the development of automatic and semi-automatic machines for the production of duplicate parts from bar stock, iron and brass castings. Many special fixtures have been designed for automatic screw machines which have widened their scope to include a great variety of small parts on which a number of operations must be performed before cutting off from the bar, such as small spiral gears, capstan screws, etc. The cost of production is so greatly reduced that these machines are generally applied where the quantity of work to be produced warrants the cost of installation and tool maintenance. The scope of other types of automatic machine tools is wide and constantly increasing. Certain examples will be mentioned later. Many pages could be devoted to the improvements in these machines alone without exhausting the topic; but attention is called here to the simplification of equipment required for the manufacture of highly developed specialties because of the possibility of buying the bulk of the parts from screw machine product specialists. A manufacturer of a specialty, can if he chooses, organize on an assembling basis, confining his actual manufacture to the making of a few principal parts. This development is having a marked influence on our export trade.

9 *Training Mechanics.* Modern methods of manufacturing are responsible for limiting the employment of men to specific operations only, and pursuit of the plan is making it hard to secure all-around machinists. Young men come into a factory and soon acquire the necessary skill to become proficient drill press operators or milling machine operators. They are able to earn fairly good wages in a shorter space of time than if they served the necessary term of apprenticeship to become competent all-around machinists. The endeavor has been made in the larger manufacturing cities to offset the narrowing effect of specialized training by the introduction of training schools in which young mechanics are given instruction in the theoretical side of their work. The results obtained by this training are beneficial. Men are acquiring both theoretical and practical knowledge, so that to a limited extent at least, they are obtaining the benefits of a technical education coupled with practical training.

10 *Scientific Management.* One of the noteworthy improvements in modern shop practice is the application of *the principles* of scientific management. While the details and elements that make up the complete system advocated by Mr. Taylor are not widely used in full, undoubtedly the fundamental principles are coming to be more thoroughly understood and are being quite generally applied. Some of the more specific improvements referred to in the following may not be strictly modern, but doubtless most of them can be so classified because they are now common, whereas ten years ago they were found in comparatively few shops.

11 *Standardization of Tool Grinding.* The turning and planing tools in many shops are now ground to standard shapes in the tool-room on special tool grinding machines. This method not only saves the time of the machine tool operator, but insures the grinding of all tools to the correct form and it also saves what is of greater value—the loss of the productive time of the machine tool. The stock of tools required for a shop is also much smaller.

12 *Checking System for Small Tools.* Most shops at the present time keep all small tools in the store-room, except those in actual use. In this way, the tools are kept in good condition and a much smaller stock is required. Not many years ago it was quite common for each workman to have his own stock of tools. Consequently there were good tools and poor tools just in proportion as there are good workmen and bad workmen. For instance, a lathe operator had his own stock of mandrels which were made to suit each particular job, and when necessary one man borrowed from another. The result was that the workmen wasted a great deal of time wandering around looking for mandrels and other auxiliary equipment. It may seem somewhat out of place to refer to this well-known method of handling small tools by a checking system in a paper on modern improvements, because it is an old feature of many shops. This system was not generally employed ten years ago in many of the small and medium sized shops.

13 In some shops in which scientific management has been applied, and where the work in connection with each operation is planned in advance, it is the practice to make up at the time the work is planned, a list of the tools that will be required for the performance of each operation, this list being sent to the tool

room in advance of the time that the tools will be required, and the tools delivered to the workman by a tool carrier, thus saving the time of the workman as well as that of his machine.

14 *Speeds and Feeds.* The important questions of speed and feed in connection with machining operations have, during recent years, been carefully studied by many superintendents and foremen who formerly relied entirely on the judgment of the workmen, which was sometimes good and sometimes bad. Speeds and feeds are fixed in the planning department and are based on the power of the machine and character of the metal.

15 *Tool Selection.* More thought is now given to the selection of machine tools for various classes of work. A few years ago, many shop foremen used a certain type of machine for a given class of work, because that type had always been used for that purpose. It seems that there is much less conservatism today and precedent does not count for as much as it did a few years ago. The tendency is to design the machine for the work instead of adapting the work to the machine equipment.

16 *Inspection of Finished Parts.* Machine parts are now carefully inspected in many shops by an independent inspection department, whereas formerly the only check on the accuracy of machined work was in the erecting department—if everything could be assembled, the work was considered satisfactory. The more exacting requirements of recent years, however, made necessary the general adoption of a rigorous system of inspection. Thorough inspection and testing are necessary features of interchangeable manufacturing methods; tools and system have become highly specialized. In the manufacture of firearms and other high-grade products from fifty to one hundred separate tests or gagings on a single part are not uncommon.

17 In some shops doing work of a miscellaneous character, it is the practice to have an inspector go to the machine at the time a job is started to make sure that the workman understands all of the requirements with reference to the quality required in the work that he is to do, instructing the workman as to the degree of accuracy required, the kind of finish, etc., and seeing that he does not make a mistake in reading his drawing, setting his measuring tools, etc. The inspector inspects the work done in the operation in question upon the first piece where there are several pieces to be done, thus avoiding the danger of an error on the first piece being repeated on all subsequent pieces. An

inspection is also made upon the completion of each operation of the work done on all pieces in the lot for the purpose of detecting any error that may have been made, so that steps may be taken for its correction without delay.

18 *Cooling Lubricants.* Another improvement in shop practice worthy of mention is the more generous use of cooling mediums on cutting tools, and the provision of distribution systems for both the tools and the bearings supplied from a central reservoir.

19 *Use of Multiple Tools.* The increasing use of tools in multiple is a feature that is noticeable in connection with the modern machine shop. Milling machines are now quite extensively used having several spindles, making possible the finishing of three or even five sides of a casting at one setting, many holes are drilled simultaneously and in practically the same time formerly required for drilling one hole, and so on.

20 *Better Facilities for Setting up Work.* The up-to-date foreman or superintendent has come to realize that the efficiency of his shop depend largely on the amount of attention given to the little things. The furnishing of proper clamps and bolts to machine tool operators is a case in point. Poor bolts and warped clamps around a machine often double the time required for setting up work. At the present, most shops are equipped with proper clamping facilities and, in many cases, clamps of the right shape and bolts of the right length are furnished for each particular job, along with the other tools, such as cutters, reamers, etc.

21 These tools are being kept in the toolroom instead of being kept at the machines as formerly; thus the responsibility for their maintenance in first class condition is concentrated in the toolroom, where they are inspected upon being returned after their use in connection with each job, and any necessary repairs promptly made. The difficulty of holding a large number of men responsible for the upkeep of these tools is thus avoided, and each workman has a larger variety of bolts, clamps, blocks, etc. to draw upon than he can possibly have where each man has his own supply.

22 *Location of Tools and Lighting.* More attention is given to the relative location of tools in the shop, in order that all machining operations can be performed with no unnecessary handling of the work, the aim being to finish parts by advanc-

ing them from one tool to another in a direct line without any see-sawing or useless movements. Shops are constructed so that the light will be properly diffused, which makes it easier for the machinist to do accurate work and reduces the amount of spoiled work. The physical comfort of the workmen is also receiving more and more attention.

23 *Drilling Machines.* High-speed steel has been substituted for carbon steel in the manufacture of twist and flat twist drills with marked improvement in capacity. The speed of drilling has been increased two or three times, if not more. The drilling machine, the most common machine tool, has been redesigned to meet the new requirements and so rapid are some of the most highly developed machines on the market, that holes can be drilled in boiler plate quicker than they can be punched.

24 The claim is made by engineers who have carefully investigated the matter, that eighty per cent of all the holes drilled in general manufacturing are three-quarters inch in diameter or less. The fact is pointed out that general purpose drills with a capacity of from one-eighth inch to three inches are not efficient except within a narrow zone somewhere between the two extremes cited, desirable as they are when on deep drilling or on large diameters requiring a geared drive; hence the general recognition of the importance of comparatively small capacity drilling machines in the equipment of efficient plants.

25 Multiple drilling machines with from two to fifty or more drills in operation simultaneously, have been developed. Inverted drilling machines with which the capacity of drills is increased largely because of the rapid clearing of chips from the holes are being used with satisfaction, also multiple drilling machines working in several planes simultaneously, making feasible the drilling and reaming of all holes in machine parts such as automobile cylinders at one operation. Another development is the rotary table semi-automatic drilling machines which relieve the operator of lifting and lowering the spindle and engaging and disengaging the feed.

26 A minor improvement of machine shop equipment which has increased the productive capacity of single-spindle drilling machines is the so-called roller grip drill chuck which enables the operator to insert and remove drills, reamers, counterbores and other tools without stopping the spindle. These chucks are useful for certain kinds of work requiring drilling, ream-

ing and counterboring operations. In the same connection, mention should be made of tapping attachments, stud setting chucks, drill speeders, and similar attachments which improve the working range of drilling machines.

27 The need of the old style reversing countershaft has been eliminated from drilling machines by automatically reversing tapping attachments, automatically opening stud-setters; and many screw-threading operations are now performed on drill-presses with special forms of automatically opening dies, at a great saving over the former method of chucking the work on a turret lathe.

28 *Lathes.* The improvements in lathes have been chiefly in matters of strength, power, and details of construction. Spindles are made larger and are supported in longer bearings, improvements have been made in carriages, tailstocks, tool-rests, apron mechanism, stops, ways, spindle noses, gear boxes, change gear and feed mechanisms, etc.. Three-stop cone pulley and double back gear headstocks have been widely adopted for high-power rapid reduction lathes, this construction providing a wide range of speeds with simple and efficient mechanism. Quick change gear mechanisms which enable the selection of gear combinations for screw thread cutting to be made practically instantaneously have been generally provided by lathe builders. The demand for simple lathes, that is lathes without change gears, lead screws and other standard features of complete engine lathes, has not been insistent. Hence we still have the anomaly of thousands of lathes in manufacturing plants that are never used for thread cutting but which have the change gears, lead-screws and other parts required for screw cutting.

29 The reason ascribed by one prominent lathe builder is that the application of the simpler mechanism required for feeding only, makes comparatively little difference in the cost of a lathe. The elimination of the change gears reduces the number of available feeds. But the chief objection is the loss of inventory value when regarded as second-hand tools.

30 *Wheel Lathes.* A remarkable increase of efficiency has been made in locomotive driving wheel and car wheel lathes. Ten years ago, turning the tires of two pairs of drivers was a good day's work, and most railway shops did much less. High-speed steel has worked perhaps one of its greatest triumphs in this field. Tire turning lathes have been developed to equal

the capacity of the best steels and the productive capacity has been increased to eight or ten pairs of drivers a day. The increase of capacity of steel tire car wheel lathes is nearly as great, having been raised from five or six pairs to eighteen or twenty pairs a day.

31 *Planer Drives.* A weak feature of planers and a serious limitation to the power of large planers, is the common shifting belt reversing mechanism. On small planers even the shifting belts are objectionable because of slipping and the characteristic squeaking noises, but on large planers their fault is of more serious nature. Wide belts necessary to transmit the required power at practical speeds cannot be shifted from the tight to the loose pulleys and *vive versa* quickly. Clutches of various designs are used with varying degrees of success. The reversing electric motor direct connected to the planer drive has been developed to the point that makes its success assured. Probably this change of drive is the most marked improvement in planers made in recent years. Many details have been improved and the greater strength and rigidity of the modern planer coupled with excellent workmanship insures accurate work.

32 *Milling Machines.* A change in the machines for producing plane surfaces has been going on gradually but surely. Planers, shapers and slotting machines are being displaced by various types of milling machines in manufacturing plants. As plants change from a building to a manufacturing basis, the superiority of the milling machine as a manufacturing machine gives it the preference. The development of coarse-pitch teeth milling cutters and of face milling machines, are two of the marked improvements.

33 Single pulley drive with which the maximum power capacity of a given width belt can be transmitted to the machine irrespective of the work spindle speed, and geared speed boxes giving a wide range of positive speeds are other important changes in design. The vertical spindle milling machine has been developed to a high plane of efficiency, especially for small work. Rotary table machines with quick action clamping devices revolving continually while the operator places the work in position and removes the finished parts, are coming into extensive use.

34 Characteristics of modern milling machines also common to other modern machine tools are convenience and ease of opera-

tion, starting and stopping levers being placed where the operator can grasp them without leaving his normal position; speed and feed levers so placed as to permit the operator to control the rate of cutting while watching the work; power traverse of slides on heavy machines; etc.

35 *Boring Mills and Boring Machines.* The boring mill has taken a commanding place as a machine tool for both light and heavy work. When equipped with turret heads and a proper complement of tools its productive capacity has been made second to none. Convenience of operation, economy of floor space, compactness of design, adaptability to use of lubricants on cutting tools, are some of the advantages of this machine which have been emphasized in the new designs brought out in recent years. The builders have studied to find the best order of operations and equip with chucks and tools that produce an output far in advance of that possible ten years ago.

36 The horizontal boring machine of the bed and carriage type which has been developed practically within the past ten years, partakes of the characteristics of the lathe, milling machine and boring mill, and in the improved designs is superior to any one, for certain classes of work. One of many uses to which it is devoted is that of boring jigs and fixtures for interchangeable production. Not only is it useful for jig making but it is peculiarly well suited for manufacturing machine parts interchangeably without the use of jigs. This important fact enables machine tools and similar high-grade machines to be economically produced on the interchangeable plan during the very active period of developing the design.

37 *Magnetic Chucks.* Magnetism for holding steel and iron parts for grinding, planing and turning operations has been made useful, especially for thin parts that are easily sprung out of shape by ordinary clamping means. Magnetic grinding, planing and lathe chucks have come into common use in plants having up-to-date equipment.

38 *Grinding Machines.* The surface grinder, especially the vertical spindle type, has made great strides during the last few years. The improvements in cylindrical grinding methods are also worthy of mention, especially the use of the heavy-duty grinder for removing stock formerly removed by a second or finishing cut in a lathe. Grinding stock from the rough as in the finishing of drop forged crankshafts is also a good ex-

ample of modern practice. The stage has been reached in cylindrical grinding practice which places the cylindrical grinding machine on a coordinate basis with the lathe as a tool for finishing cylindrical work. A feature of cylindrical grinding machines which has greatly increased productive capacity in multiple diameter work is the stop bar or semi-automatic measuring attachment which enables shouldered shafts, etc., to be duplicated without measurement. Machines for internal grinding of non-revolving work with planetary spindles provides for the economical and accurate sizing of engine cylinders and other parts difficult to rotate. Vertical grinding machines and rotary work-tables utilizing magnetic chucks or other quick action clamping means for quickly securing and releasing the parts to be ground have come into extensive use for high-grade interchangeable manufacturing. The development of the disk grinder from a mere smoothing machine to a powerful machine tool of great capacity for finishing plane and curved castings from the rough is one of the most interesting phases of modern practice.

39 *Screw Thread Milling.* One of the notable improvements in the cutting of lead screws, feed screws and other machine screws, especially those required to be exact in pitch and lead is the substitution of special milling machines in place of the common engine or screw cutting lathe. Milling screws is by no means a new idea but the commerical development of special screw thread milling machines has taken place within a few years past. The machines not only increase accuracy but materially reduce the labor cost, one man being able to tend from three to six machines.

40 *Jigs and Fixtures.* The development of jigs and fixtures for interchangeable manufacturing has been remarkable. The expansion of automobile manufacture has been enormous and most of the leading concerns employ jigs and fixtures exclusively, thus insuring interchangeability, low production cost and systematic production. Many improvements have been made in the way of clamping devices, standardization of bushings, handles, levers, frames, etc., too numerous to mention specifically. Toolmaking has been developed on manufacturing lines, and in fact, several concerns specialize on the making of tools, jigs, fixtures, punches and dies, and produce them exclusively for manufacturing plants.

41 *Gear Making.* The demands of automobile users for

quiet running gears have imposed on gear makers conditions very difficult to meet. The limits of error in shape and spacing of teeth have been greatly reduced, and coupled with the necessity of making highly accurate gears, often has been that of producing them from tough alloy steels, heat treated after cutting the teeth. Hardened and casehardened gears are also demanded with minimum limits of error. The planing process has been generally substituted for milling in the manufacture of high grade bevel gears, thus producing theoretically correct tooth shapes instead of the approximation possible only by the formed milling cutter process.

42 Gear hobbing machines have been widely adopted for cutting spur and spiral gears, because of the greatly increased capacity and simplicity of operation. Machines and methods for cutting the teeth of integral herringbone gears cheaply, have been developed, thus making this form of gear available for machinery generally in which it has not been commonly used because of high cost of the two-part type. The demand of automobile users for noiseless gears have led to grinding the teeth of gears after hardening to correct form, and form grinding generally, including splined shafts for automobile change gear shafts and similar parts. Progress has been effected in the making of gears by the hot rolling process, producing them thus with a minimum waste of material and of exceptional physical characteristics. Progress has been made in the use of rotary cutters in gear manufacture. The substitution of high-speed steel for carbon steel has, of course, made higher cutting speeds possible, and improved designs of gear cutting machines have in turn made the cutters work more efficiently because of greater power and rigidity of support. Exhausts to draw away the chips and cool the cutters have made a notable improvement in efficiency, making greater speed and smoother cutting possible.

43 *Small Tools.* The design and manufacture of small tools have been improved principally in details. There has been a tendency to decrease the number of teeth of milling cutters, making possible heavier roughing cuts with proportionately less expenditure of power. While the extreme coarse spacing of the teeth advocated by some leading engineers has not been generally adopted, all manufacturers of milling cutters have, to some extent, modified the tooth spacing of their cutters. Several

special milling cutters with inserted teeth have also been proposed and, to some extent, adopted. The tendency has been towards the design of easily adjusted removable blade type reamers, and several satisfactory designs have been brought out. The flat twisted high-speed steel drill has been commercially developed, and several modifications of it have been placed on the market. The main progress in tap making, perhaps, has been towards a more satisfactory shape of the flute, and several tap makers have made experiments in this direction.

44 In general, there has been an attempt to design inserted cutter tools to a greater extent than formerly. This activity has been prompted largely by the high price of high-speed steel which has made it necessary to make the cutters only from this material, while the body and shanks of the tools are made of machine steel. Many experiments have been made to find the steels best adapted for a given service and the best heat treatment for the selected steels. Improvements have been made in the tangs of twist and flat drills adding strength sufficient to enable them to stand up to the requirements of high-speed drilling and drilling machines.

45 *Micrometers and Gages.* During the past ten years, the micrometer has become a measuring tool of general use. Almost every mechanic employed in up-to-date shops, who owns a kit of tools, regards a "mike" as necessary as calipers. Many shops also supply them from the tool-rooms on the workman's checks. As the result of the general use of the micrometer, one-thousandth inch has become the unit of measurement for fixing limits, and a limit of one-quarter thousandth is not uncommon in grinding operations. Not only is there a great advantage in the matter of accuracy in the use of micrometers over the old style of calipers set to a scale, but there is a considerable saving in time through their use, both in the matter of setting to size and in eliminating the element of uncertainty, permitting the workman to proceed with his work with greater confidence. So general has the use of this unit become, and so convenient is it for small dimensions, that a strong movement is under way to make it the standard for measuring wire, sheet metals, etc., in place of the irrational and arbitrary wire and sheet metal gages. One of the largest electrical concerns abandoned the wire and sheet metal gage systems in 1904 and adopted the decimal system in which one thousandth inch is the limit for use in all specifications of wire, sheet metal, fibre, etc.

46 Standard length gages have been improved. The so-called Swedish gages are furnished under guarantee of error being not more than one one-hundred thousandth inch, per inch length, the limit of error being proportional to the length. Thus a gage one-tenth inch long has an error limit of one-millionth inch, and so on. Hence a stack of these gages presents an over-all length accurate to limit of one one-hundred-thousandth inch per inch of length.

47 *Screw Threads.* The so-called United States or Sellers standard screw threads have come into general use for machine construction during the past twenty or twenty-five years and have proved generally satisfactory for locomotives, cars, steam engines, and other typical heavy machinery but the automobile brought a new condition for which the standard threads were not well fitted. It was found that the jar and vibration to which motor cars are subjected, speedily loosened the comparatively coarse thread screws and nuts threaded to these pitches, and the need of finer pitches was soon recognized. We now have the finer screw pitches established by the Society of Automobile Engineers, and the merits of these pitches have won them recognition in other lines of machinery where for constructive reasons, pitches finer than the United States standard were desirable.

48 The A. S. M. E. standards for machine screws, which were adopted after a thorough investigation of the problem, should be mentioned also, in this connection. No work that this society has done is of greater importance than that of fixing on standards of screw threads to be recommended to the engineering profession.

49 *Portable Tools.* An important factor in shop work is the portable electric motor drilling and reaming machine which has been developed in several efficient forms during the last decade. These portable machines, supplemented with the pneumatic riveting, chipping and chalking hammers, have virtually revolutionized shipbuilding, bridge-building, and structural steel work, and in the erection shop have wrought great changes, making possible rapid and efficient machine work on the parts as erected and thus saving labor and time through the elimination of transport to and from stationary machines.

50 *Power Hack Saws.* The first power hack saw machine was put on the market about twenty-five years ago. During the past few years the range and capacity of these machines has been greatly extended. They are furnished with quick return

stroke, relief action for back stroke, means for using the full length of the blade, angle chucks and other improvements that have made this humble machine a real machine tool of high efficiency and low operating cost. Blades of great durability are furnished at low cost.

51 *Brass Working.* The changes in brass working are principally in the development of automatic and semi-automatic machines for machining standard parts made in large quantities. Some of the machines have effected great reductions in cost, in some cases reducing the labor cost to one-fifth, or less, of that before the change was made. Carbon steel tools still have the call in some plants in preference to high-speed steel tools; carbon steel holds a keener edge and is generally more satisfactory for working the brass used in the manufacture of globe valves, cocks, etc. It is claimed, however, that much of the difficulty experienced in using high-speed steel on work of this character is due to improper heat treatment of the high-speed steel, and this contention seems to be borne out in practice as certain shops doing brass work of this character are using high-speed steel exclusively.

52 Chucks operated by compressed air have made a great improvement in the operating efficiency of brass lathes. The work can be chucked and removed without stopping the work spindle, thus saving the time and strength of the operator. The development of the air chuck has taken place chiefly within the past few years, and it is one of the principal improvements made in hand operated turret lathes.

53 *Manufacture of Guns and Pistols.* The methods of making guns, pistols and similar high-grade products have been revolutionized. A representative of one of the largest machine tool building concerns estimates that the efficiency of workmen in these lines has been doubled by the introduction of improved machinery and methods. When the fact is considered that high grade gun parts are made interchangeable, the limits of error allowed being very small indeed and that gun making is one of the oldest industries, the importance of the improvements made can be better appreciated.

54 *Press Working.* Press working machines, punches, dies and other tools, have developed to an extent not generally realized by engineers in lines not affected. Here again the development of highly specialized methods of manufacturing automobiles has had a marked influence. Crank presses of one thousand tons capacity are in use. Pressed metal forms of large size are

a commonplace. But not only has the development been remarkable in point of size, but also in detail of manipulation. Parts requiring several operations, for example, are turned out by multiple plunger presses, one finished piece being formed at every stroke. An interesting feature of press work is that shapes are produced impossible of duplication by any other known process. In this respect, press work differs from most other machining processes; it is possible to duplicate, for example, lathe or planer work by hand tools, but not so many drawing and forming operations in daily use. A branch of presswork little known is the extrusion of shells, tubes, collapsible tubes, etc., of copper, brass and alloys. Extrusion of bars in many shapes used in manufacturing locks, small machines, etc., has become a large industry which has been largely developed in recent years. The possibilities of extrusion are practically unlimited, and this process in common with other metal working methods extensively used has an important effect on the practice of shops using the shapes in their products.

55 *Heat Treatment.* The advent of the high-speed steels and the alloy steels used in automobile gears, shafts and other high grade machinery subjected to shocks has necessitated the development of furnaces and equipment for the scientific heat treatment of steel. Accurate determinations of quenching and annealing temperatures are absolutely necessary, and the pyrometer has become an indispensable instrument in the furnace room. Gas and oil furnaces have been greatly improved in the matters of efficient use of fuel and control of temperatures.

56 *Die Casting.* The production of alloy castings in metal dies has grown to large proportions. Gears, bushings, bearings, type wheels, machine parts, covers, etc., are produced accurate to pattern and free from fins. This phase of manufacturing machine parts has a decided bearing on machine design. The extension of die casting to include not only the low melting alloys but also brass and cast iron, promises to make decided changes in some lines. Cast-iron gears true to pattern on which machine work is reduced to the boring of the hub for the shaft, may become common in agricultural and similar grades of machinery.

57 *Ball Burnishing.* Finishing processes are important in giving attractiveness to manufactured goods. Hand methods are slow and costly and the natural tendency is to use automatic mechanical methods for finishing as well as for making. One

process of considerable interest because of its simplicity and effectiveness is the steel ball burnishing method, consisting essentially of a tumbling barrel partly filled with the articles to be finished and a mass of hardened steel balls of various sizes.

58 *Thermit Welding.* An effective process has been introduced extensively during the period covered, for welding heavy sections of steel and iron. The thermit process is being successfully used for welding broken locomotive frames, cylinders, crankshafts, propeller shafts up to any thickness and diameter. The fractures are soundly united by a steel bond applied *in situ* at a fraction of the cost of removing the parts, welding them in the smith shop, finishing in the machine shop and replacing. Hundreds of locomotive frames have been welded by this process with almost uniform satisfaction and at a saving.

59 *Autogenous Flame Welding and Cutting.* The development of oxy-acetylene and oxy-hydrogen welding and cutting torches has given the industrial world truly remarkable tools for building up or cutting apart. The welding of sheet metals is accomplished with speed and evenness hardly possible by any other process, and the cutting of steel or wrought iron is done close to the line and with such rapidily as to equal or exceed the performance of any machine tool adapted for the same work. Recent improvements make possible the cutting of all manner of shapes from steel plates up to six inches thickness so close to the outline of the pattern that a light finishing cut suffices to transform the piece into a finished die.

60 *Cranes, Hoists and Trolleys.* The general provision of traveling cranes, jib cranes, hoists and trolleys in modern shops have made a great change in the manner of handling work and the attitude of mechanics to big jobs. When a casting weighing many tons had to be machined in the old-time shop it was a herculean job to transport it from one machine to another and fix it in position. So general has the power traveling crane become in the past few years that it is a commonplace sight to see machine parts weighing many tons being transported through shops and placed on machines with no fuss and requiring the help of only one or two men besides the crane operator.

61 *Accident Prevention.* The prevention of industrial accidents has received wide attention in industrial establishments. In machine shops accident prevention is a relatively simple matter, but there are a few points of danger which have become generally appreciated, and all of the better types of machines are

equipped with guards to cover gearings, setscrews, flywheels and all moving parts not necessarily exposed. There are also certain sources of danger which exist in practically all manufacturing plants and the general rules to prevent accidents from slipping ladders, piles of castings, elevators, etc., are being applied.

62 Time and space will not permit going much more into detail, and the following are enumerated without elaboration: Introduction of ball bearings in the construction of machine tools, effecting a saving of power, increasing the efficiency of operation, and capacity through reduction of bearing widths; development of cam grinding machinery and attachments making possible the rapid and economical production of camshafts having cams integral with the shaft; development of the dynamic balancing machine and the general recognition of the need of dynamic balancing for high-speed revolving parts; artificial production of highly-efficient abrasives or cutting particles for grinding wheels, and improvements in grinding wheel manufacture; development of improved lubricating systems for machine tool bearings; development of machine tools to their utmost capacity by providing means for working the tools all the time, employing extra men to prepare work and also by tooling the machines to bring them up to their highest productive capacity; development of spline milling machines for cutting keyways, key slots, drift holes, cam grooves, recesses, etc.; finishing square, hexagon and other shaped holes by the broaching process, insuring interchangeability and rapid production at low cost; general improvement in sanitary conditions of shops, improved lighting facilities both by day and by night through the use of sawtooth roofs, large windows fitted with metal window frames, improved electric lights and means of distribution; provision of lockers; and the establishment of shop restaurants in localities that formerly had nothing better than the corner saloon.

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Members of Sub-Committee on Machine Shop Practice

GAS POWER SECTION

At the meeting of the Gas Power Section, held on December 4 during the Annual Meeting of the Society, the following officers were elected: Chairman, Prof. F. R. Hutton; Members of the Executive Committee, W. D. Ennis, W. H. Blauvelt, H. J. Freyn and C. H. Benjamin.

The address of the retiring Chairman, with discussion, here follows in somewhat abridged form.

RECENT DEVELOPMENT OF GAS POWER IN EUROPE

By H. J. Freyn, Milwaukee, Wis.

Chairman of the Gas Power Section

The development of the internal-combustion engine in Europe during the last year has been very marked and great strides were made, especially by the Diesel engine. The unparalleled progress of this prime mover, due primarily to the expiration of the basic Diesel patents, created a wave of enthusiasm, the crest of which swept Europe only a short time ago. To the careful observer, however, signs of an ebbing of this wave are apparent and more sober, more healthy views are gaining ground.

OIL ENGINES

Large Diesel Engines.—Without desiring to detract from the importance of the Diesel engine, investigation has proved to me that my warning against over-enthusiasm sounded about a year ago on a similar occasion was fully warranted.

In particular, I was disappointed to find that the achievements with large Diesel engines, above 1000 h.p., do not altogether coincide with the optimistic reports which have appeared in the technical press of the world during the past year or two. It is not certain that the large Diesel engine will be an undisputed commercial success

The American Society of Mechanical Engineers, 29 West 39th Street, New York

abroad, since the price of natural fuel oils is steadily increasing, thus largely limiting such engines to the use of tar oil.

The horizontal double-acting four-cycle M.A.N. Diesel engine in twin tandem arrangement of 1600-2000 b.h.p., which I had the privilege of examining at Halle a. S., is a splendid piece of machinery and operates apparently very satisfactorily on tar oil with a small addition of ignition oil. It is claimed that such an engine can be sold in Germany for from $30 to $32.50 per horse power, against $35 per horse power for a steam plant. It would be expected, however, that the repair and maintenance cost would be much higher than for a steam plant and even higher than for present gas engines, on account of the high pressures and temperatures which are essential with the Diesel working principle and because of carbonization at partial loads which can be prevented only by scrupulous cleanliness. In countries where the price of coal is high, this engine type may have some importance, and a number of such engines of even larger unit capacity than mentioned have been sold in France and Russia, where fuel conditions are favorable for this type.

Small and Medium Size Diesel Engines.—The Diesel engine in sizes of from 40 or 50 h.p. in single-cylinder units, up to about 600 h.p. in four-cylinder units, plays a vastly more important part abroad. It has unquestionably come to stay and has reached a high degree of perfection which places it in line with the corresponding steam or gas-engine plant as far as reliability and cost of operation are concerned, and far ahead of its competitors from the standpoint of fuel economy. It is amazing to note how many manufacturers of gas and steam engines abroad have taken up the manufacture of Diesel engines, because they found that the sale of suction gas producer plants and smaller steam engines had fallen off alarmingly during the last few years.

The reason is plain. The single-acting, four-cycle, single or multi-cylinder Diesel engine, but particularly the former, is comparatively simple in construction and operation, especially when its unequaled efficiency is considered, for it is certain that, generally speaking, complication of any mechanical contrivance increases with increasing efficiency. This engine is always ready to be put in service at a moment's notice and has no standby losses; it does not require upkeep and attendance of boilers or gas producers and its cost compared with that of a steam or gas plant is reasonable. It can be installed in the basements of buildings below occupied dwellings, whereas in Europe boilers are not permitted in such places. One of

the greatest advantages which can not easily be expressed in figures, but is of vast importance to the consumer, is the fact that the actual fuel consumption of Diesel engines, taken over long periods of operation, does not materially exceed the guaranteed figures, whereas in gas producer and steam plants this excess is quite considerable. A few months ago a German technical periodical contained an article showing that the actual fuel consumption during a period of one whole year was for certain Diesel engine plants only 14 per cent higher than the guaranteed figures given by the manufacturer, whereas it averaged 120 per cent more in high-class steam locomobile plants. In this comparison 27 installations containing units of 50 to 80 h.p. were investigated, 12 of which were locomobile plants, whereas 15 contained Diesel engines. In a Diesel plant the human element, the skill of the operator, must have much less influence upon the fuel economy than in a steam or producer gas plant where everything depends upon the efficiency and intelligence of the fireman and producer attendant.

While the Diesel engine was originally a vertical engine, the last two or three years have witnessed a remarkable development of the horizontal Diesel engine. With few exceptions the manufacturers of vertical Diesel engines have branched out to build horizontal engines as well for purely commercial reasons. Experience shows that the fuel consumption is only very little, if any, higher than that of vertical engines, but the horizontal type is decidedly preferred by the customer, not only on account of its lower cost, but particularly owing to its greater simplicity and better accessibility. Especially the horizontal Diesel engine with Lietzenmayer's open fuel injection nozzle offers these advantages in their full measure. The open nozzle is simpler, can be more easily cared for by unskilled attendants, gives better results when burning heavy oils and is less sensitive in its action than the so-called closed injection nozzle of the original Diesel engine. The horizontal open nozzle oil engine has the additional advantage that certain essential accessories, such as the starting gear and the fuel pump, can be designed much simpler than for the other type. Many engines of the former type are in very successful service, using all kinds of fuels and installed for various purposes, for instance, for power transmission, for operating flour mills, for lighting factories, sanitariums, office buildings, department stores and for electricity works.

The only difficulty of which some users of small and medium Diesel engines sometimes still complain is caused by the discharge

valves of the air compressors for fuel injection, and although these difficulties have been greatly reduced, numerous efforts are being made to materialize the dream of the "compressorless" Diesel engine. I had the privilege of seeing a 12 h.p. experimental engine of this type in operation, which seemed to give good results, since an oil consumption of only 0.48 to 0.5 lb. per b.h.p. hour is claimed, but it is not certain that this principle, which has been tried many times before, would be applicable for larger engines.

Marine Engines of the Diesel Type.—In view of the great importance of the Diesel engine for ship propulsion, there is little wonder that great effort is directed by many manufacturers to the design and construction of an engine which, while having nearly the same excellent fuel economy as the stationary engine, will also meet the severe requirements of simplicity, reliability and reduced first cost. That the last condition is not yet fulfilled is shown by the fact that, according to authentic information, the cost of an 800 h.p., four-cylinder, two-cycle marine engine recently built was 50 per cent higher than anticipated and 150 per cent higher than for a corresponding steam engine equipment. I was nowhere able to find the 10,000 and 15,000 h.p. Diesel engine ships of which I had read, and even enthusiasts do not believe that our modern leviathans will be propelled by Diesel engines.

The largest single Diesel engine unit now propelling any ship develops not over 2000 h.p. and there still remain many obstacles to be overcome before the single-acting multicylinder, four or two cycle Diesel engine on board ship is supplanted by the double acting engine. Vertical engines of the latter type are still in the experimental stage and their future does not appear very promising on account of the serious mechanical complications of scavenging pumps and multiplicity of scavenging valves in each cylinder head.

The lack of simplicity in these designs has prompted experiments with the so-called "valveless" two-cycle type, which presumably will become the large marine Diesel engine of the future. One valveless two-cycle experimental engine of 260 h.p. is claimed to have shown an economy as good as that of a regular two-cycle engine with scavenging valves. The mean effective pressure obtained reached 125 lb. per sq. in., which is truly remarkable in view of the extremely simple scavenging method employed.

The Junkers Oil Engine.—Among the valveless, two-cycle engines, the Junkers oil engine has attracted a great deal of attention. It has reciprocal pistons, a three-throw crankshaft, and differs essentially

from the regular type. An advantage is the excellence of the form of combustion space which, from a thermodynamic point of view, at least, gives it the distinction of being the best oil engine. Practical experience alone will tell whether its unusual design and certain mechanical disadvantages will be offset by this advantageous feature. One of the foremost authorities in Europe very graphically characterized the Junkers engine as an oil engine built around a given perfect combustion chamber in contra-distinction to all other Diesel engines where it is attempted to provide a satisfactory combustion space in an existing engine. Only a few smaller engines, mostly for marine propulsion and of the twin or three-cylinder vertical type have been built abroad. The tandem arrangement of cylinders which results in the same number of crank efforts realized in ordinary single-cylinder, double-acting, two-cycle engines has so far been applied only on two 800 h.p. three-cylinder vertical engines to be fitted in a vessel of one of the largest steamship companies. Aside from two experimental engines in Prof. Junkers' famous laboratory, no horizontal engines of this type have been built and opinions abroad are much divided concerning the future of the stationary, horizontal, tandem Junkers engine.

Conditions Affecting the Development of the Diesel Engine.—If conditions in Europe are not altogether favorable for the development of the large Diesel engine, they are much less so in this country. The misapprehension frequently prevails that the Diesel engine must have a wonderful field of usefulness in countries where crude oil is produced in very large quantities, but such is not the case. The price of oil fuel in any locality must be considered in connection with the prevailing coal price to determine whether a Diesel engine installation is economically efficient or wasteful. Cheap oil fuel will favor the Diesel engine only where coal is very expensive, as on the Pacific Coast, whereas high oil and low coal prices will exclude it from any part of the country where such conditions exist. Considering that the total cost of producing power is made up of a number of items, as interest on the money invested and depreciation of the plant, cost of fuel, cost of attendance, maintenance and repairs, cost of supplies, etc., it is evident that in Europe where fuel prices are from two to three times higher than in this country, while labor is only one half to one third as much, the item of fuel cost constitutes a very high percentage of the total cost of power, particularly since the other items, such as interest and depreciation, attendance and repairs are actually much lower and thus form a still smaller percentage of the total cost.

With us conditions are practically reversed: Our fuel cost is not only lower and our labor cost much higher than in Europe, but, moreover, the quality of our mechanical labor is not as excellent, and thus the fuel cost plays a much less important role in the total cost of power than the items into which labor largely enters: further, the lower standard of manufacture, and especially of maintenance, favors the use of simple although less economical machinery.

To what importance the use of coal tar oil has grown on the continent can be judged from the fact that France has to rely on this Diesel engine fuel almost exclusively on account of the very high import duty on natural oils. In Germany a number of collieries have combined to form a company for the utilization of tar which operates a large factory at Meiderich, where, at present, over 300,000 tons of tar a year is distilled, producing over 80,000 tons of tar oil. This is contracted for in larger quantities at a price of approximately $12.50 per ton (5 cents per gallon). With the tremendous increase in demand, it is expected that before long this one factory alone will have a capacity for handling one million tons of tar per year, producing 300,000 tons of tar oil.

It is estimated that the total world production of coal tar oil is even now in the neighborhood of 1,000,000 tons per annum, and since the recognition that coal is too valuable a fuel to be wasted in our present day furnaces is spreading more and more, the number of by-product coke oven and by-product gas producer plants will steadily increase, especially in our country, so that the total production of tar oil is certain soon to double and treble, adding to our supply of natural liquid fuels an artificial product which will by legitimate competition check the advance in the price of the former.

The heat value of tar oil is over 17,000 B.t.u. per lb. and its consumption in the Diesel engine is, therefore, not very much higher than that of natural oil, varying now from 0.49 to 0.46 lb. per b.h.p. hour, according to the size of the engine.

The operation of medium size Diesel engines on tar oil, especially of those above 50 h.p. per cylinder and with open fuel injection nozzle is satisfactory. For smaller engines the addition of a so-called ignition oil is necessary, which somewhat complicates these engines.

GAS TURBINES

Renewed activity is noticeable abroad in the matter of designing an adequate gas turbine. The foremost authorities are convinced that the gas turbine will soon come to stay and, in view of the uni-

versal tendency towards high-speed rotative machinery, the statement would seem warranted that when the gas and oil turbine does come it will revolutionize power production in the large steel centers and wherever natural fuel oils abound in this country. A large experimental gas turbine in Germany is operating splendidly, mechanically speaking, although the problem of satisfactory thermal efficiency still remains to be solved.

INDUSTRIAL WASTE GASES

The use of the so-called "industrial waste gases" has progressed considerably. The four most prominent manufacturers in Germany alone are now building large gas engines for blast furnace and steel works at the rate of 120 per year and a number of twin tandem engines of 5000 b.h.p. operating very satisfactorily on rich coke oven gas can now be seen in German coking plants.

The splendid results obtained with gas blowing engines in Germany have prevented the turbo-blower from getting a firm foothold in that country, although its use in France, England and Russia is steadily increasing. Blast furnace gas engines for blowing and electric power purposes and even for operating rolling mills are to-day the standard equipment for old and new plants, even where the coal price is fully as low as in our Pittsburgh district. Within the last two years the use of coke oven gas for producing electric power by gas engines has greatly increased, and after overcoming the many earlier difficulties the coke oven gas engine is today just as safe and reliable as the blast furnace gas engine. These difficulties arose principally from overrating the engines, and from sulphur in the engine gas. Since the reasons for the trouble were recognized, the causes, or their consequences, are now avoided, so that in a number of plants sulphur of considerably over one grain per cubic foot of gas is very successfully handled in coke oven gas engines if the proper very simple precautions are taken.

DETAILS OF CONSTRUCTION

In regard to the detail construction of the modern German gas engine a few remarks may be of interest. The most prominent gas engine builders are now governing their engines on a simple combination quantity-quality regulation principle. The valve gear has been much simplified by all manufacturers, and gas engine prices are, generally speaking, lower than they ever were before. The gas cylinders, after a few unsatisfactory attempts to use cast steel, are invariably made of cast iron and with the exception of a few types

are cast in one piece with integral water jacket. They are often provided with hard cast iron liners. The cracking of gas cylinders is now much reduced by proper design, selected material and better pouring methods. Experience has taught that the life of a gas cylinder can be materially increased if the water jackets are thoroughly cleaned from all scale and muddy deposit at regular intervals of from four to eight weeks, depending upon the character of the cooling water used. It was found by experiment that the average temperature of the cylinder wall increases at an amazing rate with even a very thin layer of scale forming in the water jacket, and in certain plants with hard cooling water, acid and wire brushes are resorted to from time to time to take the accumulated scale off the cylinder walls.

Gas cylinders on electric engines crack more frequently than on blowing engines because the former carry much higher loads than the latter and because electric engines are usually shut down oftener. It was found that frequent shutting down and starting of gas engines shortened the life of the cylinders materially if the engines were allowed to cool off too much during shut downs.

The average life of a gas cylinder in the large steel plants in Germany is pretty generally reckoned to be from five to six years. This is accepted as a matter of course and the expense incurred by replacement is simply distributed over this number of years in the cost figures.

The cost of producing electric power in German blast furnace and steel plants is about $2.70 per thousand kilowatt hours, comprising $1.25 value of the raw blast furnace gas and including cost of gas cleaning, cost of labor, repairs, and supplies of all kinds, but without interest and depreciation on the money invested. This figure applies on an annual output of about 100,000,000 kw. hours and a use factor of approximately 60 per cent.

The gas pistons are generally ribless iron castings, although for large engines cast steel is used. One concern has recently introduced for blast furnace gas engines solid, non-cooled, forged steel pistons of one piece.

The piston rods are now usually made of open hearth steel of about 100,000 lb. tensile strength, uncambered, and their diameter is approximately 26 per cent of the diameter of the gas cylinders. A variety of piston rod coupling designs is used but the threaded connection enjoys the best reputation. It is noteworthy that crossheads are made of forged nickel steel.

No uniformity of design can be claimed for piston rod packings, but they invariably consist of single or double sectional cast iron packing rings pressed against the rod by garter springs and separated by solid one-piece rings forming from 12 to 14 chambers. It is universally claimed that the clearances of the ring sections must be reduced to the possible minimum. So-called fire rings are sometimes used, but several builders object to such solid rings.

The exhaust valves are made of forged steel or of Durana metal and are now almost exclusively of the non-cooled mushroom type. Some builders, however, still prefer water-cooled exhaust valves for coke oven gas engines.

GAS CLEANING METHODS

The progress of the large gas engine in Europe has been accompanied by great improvements in the method of purifying blast furnace gas. Until recently two systems of cleaning gas for engine purposes were largely in use, both of the so-called "dynamic" type, and by using considerable quantities of water: the hydraulic fan and the Theisen washer. Results obtained with these appliances regarding both cleansing efficiency and cost of operation are satisfactory. Nevertheless, they now are superseded in Europe by new processes, which still further reduce not only the cost of installation, but principally the cost of purification on account of the smaller power and water consumption.

One of these new methods is a radical departure from the former wet-cleaning processes and works on the principle of filtering the gas in a perfectly dry condition, so that no water is required save that necessary to cool the engine gas to atmospheric temperature. The filtering is achieved by means of Beth filter bags, which are made of special fabric and suspended vertically in several air tight compartments. The raw blast furnace gas coming from the furnaces at high temperature is first cooled by radiation to about dew point (around 130 deg. fahr.) and thereupon superheated approximately 20 to 30 deg. fahr. by using any available source of heat, such as waste heat from gas engines, exhaust steam or even the sensible heat of the raw blast furnace gas itself. By cooling the gas a large amount of moisture is removed and the scorching or burning of the filter bags prevented, whereas the subsequent superheating avoids condensation of the remaining vapor and clogging of the bags. The raw gas under the action of a fan passes from the inside to the outside of the filter bags, depositing all impurities on the surface.

The layer of dust naturally increases continually and would eventually render the bags impenetrable, were it not for an automatic mechanism which in a fashion, similar to that used in flour mills, shakes the bags at regular intervals of about four minutes and causes the dust to drop off. Simultaneously the compartment which is to be cleaned is automatically separated from the others, and the direction of gas current reversed; the purified gas surrounding the filter bags now enters the latter, opening the pores of the filter material, which were previously closed up by the passing dirty gas current. The dust shaken off the filter bags falls into a receptacle, from which it is removed in a perfectly dry condition.

Two experimental filter plants installed at Halberger Huette and Duedelingen have capacities of about 10,000 and 14,000 cu. ft. of gas per minute and clean the gas for gas engines only. It is claimed that the power consumption is 2.5 to 3 times lower than that of hydraulic fans and Theisen washers, that the water consumption is only one-fifth to one-sixth of the corresponding requirements of wet-cleaning plants, and that the dust content in the purified gas is below 0.0004 grains per cu. ft., or fifteen to thirty times lower than in the purified gas obtained with the older wet cleaning apparatus. The cost of operation is furthermore claimed to be lower and the cost of installation only a little, if any, higher.

As the advantage of using thoroughly cleaned blast furnace gas, not only for gas engines, but for boilers and stoves is more and more appreciated, this "Halberger" System causes much interest and comment and several prominent blast furnace men abroad assert that the cleanest blast furnace gas obtainable at comparatively low cost is just clean enough even for boilers and stoves, which, after all, form precisely as important and costly a part of their installation as the gas engines. In certain districts of Germany and Luxemburg, water is exceedingly scarce, and the laws against river contamination are so strict that large sums of money have to be spent to purify the washing water before it can be disposed of. Setting tanks of huge area have to be installed, and the disposal of the mud presents difficulties and is very costly; furthermore, flue dust in a moistened condition is of no use except as filling in material and since it contains considerable quantities of iron ore, its disposal in such a way is rather wasteful.

On the strength of the satisfactory results obtained, many blast furnace plants in the Minette District, and even in Westphalia, have decided to install gas filtering plants, varying in capacity from 17,500 to 140,000 cu. ft. of gas per minute. One manufacturing concern alone, which acquired the rights for Germany, had in the month of July orders for twenty-one plants, with a total capacity of 825,000 cu. ft. of gas per minute and valued at one million dollars.

The other new system of gas cleaning makes use of the "disintegrator" principle. Two well known concerns in Germany, specializing in gas washing apparatus, have developed this system on somewhat different lines, and one of them claims to have on hand orders for disintegrator gas washers capable of purifying 1,750,000 cu. ft. of gas per minute. One machine only is used for preliminary purification of boiler and stove gas, from 2 to 3 grains of dust per cubic foot to 0.088 to 0.175 grains, with a water consumption of only 10 gallons and a power consumption not exceeding 0.072 h.p. per 1000 cu. ft. For gas engine purposes two disintegrators are placed in tandem which causes the power consumption to increase to 0.13 h.p., the water consumption to 18 gallons per 1000 cu. ft., whereas the amount of dust in the gas drops to 0.0044 — 0.0088 grains per cu. ft.

No change has taken place in the method of purifying coke-oven gas; bog or swamp ores are still used for sulphur cleaning, although one plant at least has succeeded in overcoming the disadvantage of occasional regeneration of this material by alternate exposure to the air by regenerating it continually.

GAS PRODUCER DEVELOPMENT

It seems extraordinary that in spite of the high price of coal the development of the gas producer for power purposes has not kept pace in European countries with that of the gas engine. For many years the Mond gas producer with sulphate of ammonia recovery has been well introduced in England, and recently much interest has been shown in Germany in such plants, which offer material financial advantages over ordinary gas producer installations. Since a great deal of sulphate of ammonia now finding a ready market as an artificial fertilizer, can be recovered from the coal, the cost of gas making is considerably reduced, and installations are known where the saving thus obtained reaches the figure of $2.00 per ton of coal, which in many

cases is as much as, or more than the value of the coal itself. The gas manufactured in such plants has a heat value of about 150 B.t.u. per cu. ft., and is of very uniform quality; on account of the removal of tar and dust, it is particularly adapted for gas engines, but its low cost makes its use very profitable for all kinds of metallurgical purposes, such as heating and annealing, for calcining, roasting, distilling, for glass works operation and a variety of other industries. Ordinary coals as well as low grade fuels, such as peat, lignite, brown coal, etc., can be very successfully gasified in such plants.

COKE OVEN GAS

The growing demand for coke, which goes hand in hand with the soaring pig iron production of the world, has caused a remarkable increase in coke oven plant activity. The days of the wasteful "Bee-Hive" coke oven are fortunately past, and the highly economical by-product coke oven is gradually taking its place. The manufacture of coke entails the accumulation of large quantities of coke braise, which cannot always easily be disposed of. Successful attempts were recently made in Europe to gasify this coke dust in special gas producers. One system operates with liquid slag very much on the order of a blast furnace, whereas the other adapts a well known European producer design to the special requirements of gasification of very fine fuels. In a number of European blast furnace and coke oven plants, this coke braise will be gasified in such producers, and the resulting gas of about 150 B.t.u. per cu. ft. admixed to blast furnace gas, to increase its quantity and improve its quality.

Mixtures of industrial gases are used more and more for metallurgical and power purposes abroad; in one plant in England a mixture of blast furnace and coke oven gas is used for all heating purposes and to operate gas engines. At first glance it may seem difficult to obtain a sufficiently uniform mixture of two gases so different in specific gravity, but experience has shown that modern blast furnace gas washers of the revolving type, such as fans, Theisen washers and disintegrators are splendidly adapted for this purpose, and that changes in the quality and heat value of the mixed gas of even considerable magnitude, do not seriously affect the operation of gas engines.

In this particular steel plant another very interesting novelty of perhaps great importance for future gas engine application

is in operation, namely, a system of overloading four-cycle gas engines 25 to 35 per cent of their normal capacity.

NEW GAS ENGINE METHOD

The method devised and patented by one of the foremost gas engine manufacturers in Germany and which creates an almost perfect analogy with the condensing plant of steam engines consists in scavenging ordinary four-cycle gas engines and introducing the fresh mixture under a pressure somewhat higher than atmospheric. This is achieved by raising the pressure of the combustion air and gas in turbo blowers to a gauge pressure of a few inches of mercury and by scavenging the spent gases of the previous power stroke with a blast of this air, subsequently introducing gas and air under slight pressure into the combustion chamber. By utilizing the waste heat of the gas engines for raising steam in suitable waste heat boilers and driving steam turbines direct-connected to the turbo blowers, the power requirements of the auxiliaries can be amply supplied without resorting to outside sources of power, nor detracting from the increased output of the gas engine generator.

An overload of 35 per cent was attained without raising the initial pressure—an important point—and without appreciable increase of the heat absorbed by the cooling water; the thermal efficiency of the scavenged engine was found to be somewhat better and the mechanical efficiency considerably better than that of the non-scavenged engine.

In another steel plant two tandem engines of 1360 kw. or 2000 b.h.p. normal rating (at 65 lb. m.e.p.), which were provided with generators of 1700 kw. capacity in anticipation of the overload scheme, can carry loads of 1800 to 2000 kw.; before the changes were made in April, 1912, the average kilowatt output per engine in twelve hours as ascertained from the log book was 13,000 kw. hours, but since installing the scavenging plant, the average output was raised to 18,000 and 20,000 kw. hours in a twelve-hour run, corresponding to an average increase of approximately 40 per cent.

Regarding the financial aspect of the matter, it can be shown that the capacity of an existing gas engine plant can be increased 30 per cent, provided the generators are large enough, at a considerable saving compared with the cost of providing for this increase in capacity by installing additional non-scavenged units.

HUMPHREY GAS PUMP

The technical press has been rather silent during the last year regarding the Humphrey pump, but according to reliable information, this is by no means an indication that this gas pump has passed out of existence; on the contrary, one of the largest concerns in Germany is devoting much time and effort on experiments to generate electric power with such a pump at its factory, and a 40,000,000 gallon pump will be installed in England on which a coal consumption of one pound per effective pump horsepower was guaranteed.

DISCUSSION

William T. Magruder. I had the pleasure of spending a few months on the other side of the water this past summer, and looked at the subject of gas-power from a different point of view from Mr. Freyn. I considered it both from the engineering and educational sides and received much information not only from manufacturers as to costs and details, but also from professors of engineering. In the first place, I noted, in both Germany and England, that the most important developments in gas and oil engines in recent years have been made by consulting engineers, who are graduates of universities and engineering colleges, many of whom are professors or lecturers who are doing much advanced work along the line of investigation. Secondly, that societies like the Institution of Civil Engineers and the Institution of Mechanical Engineers, the British Association for the Advancement of Science, and the Society of German Engineers, are deeply interested in the subject of gas power, and their members are doing the largest part of the scientific work. It is interesting to note the number of papers presented to these learned societies from men who have received higher degrees, such as Master of Arts, Doctor of Science, and Doctor of Engineering. I would respectfully recommend their activities to the attention of The American Society of Mechanical Engineers, and the American Association for the Advancement of Science, as it is high time that they too become more active and that our Research Committee on Gas Power did something in the way of scientific research in the field of gas and oil engines.

Few Americans appreciate the tremendous difference between the gas and oil engine industry in Europe and in America. The price of gasolene in Great Britain is 40 to 45 cents for an Im-

perial gallon, which is the equivalent of 33 to 37 cents for the American gallon, or double the price as compared with 15 or 16 cents, paid for the same amount in the United States. It can readily be seen why Englishmen are now looking for a cheaper fuel than gasolene, as Americans will be shortly doing, and why oil engines operated by tar oil are being used especially in Germany, although it is a much less desirable fuel than other oils on account of the difficulty in igniting it. It can be seen why gas producers operated by the combustion of peat briquets in Scotland and Germany and bituminous gas producers are favorably regarded. Because Dr. Mond happened to live in England, the Mond producer is more commonly used in England than in Germany. It used to be that 1500 h.p. was the smallest unit that could be economically installed and used. I was told by one manufacturer in England that now they could be economically used in England in plants as small as 800 h.p. One of the interesting and surprising things was to see the large numbers of gas and oil engines on the testing floor and of producers in the assembly buildings, to go through the painting and shipping rooms and to be told that the output of several of the works visited was from 2000 to 3000 gas and oil engines per year and 30 producers a month. The reason for this, it was stated, was the low price of city gas and the relatively high price of coal.

The smaller proportionate number of motor cars used in England as compared with this country is doubtless due to the relative prices of suitable fuel. I was informed that there are 150,000 motor cars in Great Britain for a population of fifty million people, or about three cars per 1000 of inhabitants. In this country, almost 1,000,000 motor cars were registered in 1912, to say nothing of the motorcycles, motor boats and other users of oil-power; or one car for each 100 of the inhabitants of the United States, and that the ratio of cars to people in this country is three and one-third times as large as in Great Britain. If there were the same proportionate number of cars used in Great Britain and on the Continent, for which I have no accurate figures, as in America, the price of fuel in Europe would be still greater than it is. But to this large number of motor-car engines must be added more than 1,000,000 gasolene engines used for farm work and in motor boats in this country. Taking the average horsepower of the motor cars to be 25 and of the motor boats and farm engines to be 10, thirty-five million horsepower

of gasolene engines are immediately available for the practical generation of power in this country. Suppose they used as a minimum at rated load ¾ lb. or 1 pt. of gasolene per h.p. per hr. for 1 hour of use they would generate thirty-five million horsepower and require four and a half million gallons of gasolene at an estimated cost of $700,000. The total annual supply of American gasolene is estimated to be one billion, five hundred million gallons, and that would last only 333 hours. If every gasolene engine were run at its rated load each day, the annual distillation of gasolene in this country would be sufficient to permit them to be operated for only one hour per day, or 333 hours per year. In other words, our present annual output of gasolene is sufficient to operate continually at their rated load only 5 per cent of the gasolene engines now sold and in operation.

These being the facts as I gather them from statistics published by the Bureau of Mines, and other reliable sources, it can readily be seen to be a case of supply and demand. It is probable that some other fuel than gasolene must come into use for oil engines and that this fuel will be kerosene. When the vast amount of kerosene that is now on the market is realized, three billions of gallons being distilled annually, it seems certain that kerosene oil will come into very great and general use in the next few years.

It was interesting to note how the kerosene oil engine is being introduced and used in England and on the Continent in place of the gasolene engine and particularly in the form of the so-called semi-Diesel oil engine, and from which results below ½ lb. of kerosene per h.p. per hr. have been reported by expert engineers. This is a branch of the gas power field that Americans are only beginning to cultivate with any degree of efficiency.

The figures that I obtained abroad in respect to the fuel consumption of Diesel engines may be of interest. The actual fuel consumption of a large plant on test was 0.44 lb. of oil per b.h.p-hr. at full load, 0.45 lb. at three-quarter load, 0.47 lb. at one-half load, and 0.62 lb. at one-quarter load. Other figures obtained in tenders for alternating-current electrical units of 200 to 300 kw. capacity running on crude fuel oil having a calorific value of 18,000 b.t.u. per lb., varied for four-cycle Diesel engines from 0.603 to 0.662 lb. at full load per kw-hr., from 0.64 to 0.70 lb. at three-fourths load, from 0.70 to 0.83 lb. at one-half load, and from 1.14 to 1.27 lb. of oil per kw-hr. at quarter load. These figures confirm Mr. Haynie's remarks upon this point.

With respect to the first cost of Diesel engines, Mr. Freyn has given $32 to $35 per h.p. The lowest price given me in England on Diesel engines was $35 per b.h.p. and from $35 to $45 seemed to be the usual price for Diesel engines in the larger units.

In the tenders above referred to for Diesel units of 200 and 300 kw. capacities, the prices for the engines directly coupled to alternating-current generators varied from £13-16-4 for the 300-kw. units at 192.5 r.p.m., to £22-17-3 for the 200-kw. units at 165 r.p.m., and the average price of 23 four-cycle Diesel engines and alternating-current generators of 200 and 300 kw. capacities from seven builders averaged £17-7-11 per kw. of rated capacity. These are the equivalents of $67, $111, and $85 respectively. The horizontal engine units were about $15 per kw. less in price than the vertical ones. The corresponding figures for the gas-producer plant with engines and generator without foundations were £19, or $92, installed.

With respect to the Diesel ships, any one who has seen them operated, especially in local service, and seen the delightful ease and speed with which the engineer operates their valves, stops the generation of power and the rotation of the screw, and then reverses and starts up in the opposite direction, and seen them come to rest as soon as their momentum can be absorbed, cannot but admire the Diesel engine for marine purposes.

With respect to the Diesel locomotive, I cannot say as much. The one I saw would be simply prohibitive at the present time on account of first cost, labor in operation, and a number of other difficulties, which may yet be overcome.

The whole subject of oil power at the present time reduces itself to costs of fuels and to the usual commercial and engineering problems. If our commercial friends would be more fearless and less secretive and our scientific friends would be more energetic, the cause of the Diesel and other forms of oil engines, and of gas power in general, would be advanced.

W. R. Haynie (written)[1]. It may be generally stated that all heavier oils, if free from non-combustible foreign matter, can be readily used in Diesel engines. The non-combustible foreign matter is sand or mineral matter that will not burn, but will cut the engine cylinders; it can always be removed either by

[1] U. S. Representative, Carels Frères (Ghent, Belgium), 30 Church St., New York.

precipitation or by forced straining, and there is no petroleum residue of however heavy specific gravity, the ignition of which is not attainable by the temperature created by 30 to 35 atmospheres of compression. The complete combustion of the fuel oil in the cylinders after ignition is, however, entirely dependent upon the process of handling the fuel before it enters the cylinders. The period during which the oil has to be consumed is very short, only a small fraction of a second, and therefore the process of combustion must take place almost instantaneously. The rapidity with which the oil is consumed depends not upon its specific gravity or chemical properties, but upon the size of the particles or globules into which it is broken before coming in contact with the ignition temperature. The combustion proceeds over the surface of the particles, and the smaller the particles, the more quickly they are consumed. But when heavy residues are used in the Diesel engine without reducing the size of the globules, only the surfaces of the particles are consumed in the short time allowed for combustion, with the result that the interior portion is converted into a pitchy substance which deposits on the surface of cylinders, pistons and valves, and produces waste of oil and clogging of the cylinder and valves. The oil entering the cylinder should therefore be completely atomized.

The resultant effect of an oil used in the Diesel engine depends entirely upon its heat value, and therefore with the same heat units per lb. an oil of 0.97 specific gravity will produce the same energy results in a Diesel engine as a lighter oil of 0.85 specific gravity.

The speaker further stated that although he has read now and then in the papers of 6000 and 12,000-h.p. Diesel engines built abroad, he found when he went to Europe that they were still all on paper; engines up to 3000 h.p. may, however, be built quite successfully. The speaker illustrated his remarks by several slides.

In connection with Mr. Haynie's discussion it was stated by one of the members that Baron Schmidt had taken out patents on a two-cycle valveless engine which is now built by Cochrane Company at Seraign, Belgium.

Professor Magruder, in replying to a question of Mr. Chubb as to the future possibilities of alcohol engines, stated that the best place to see alcohol engines in Europe is in the scrap

heap. They are not a commercial success. The theory of these engines has been fully worked out, but as long as alcohol is heavily taxed, and the trade is throttled by commercial agreements, no real development along that line can be expected.

D. G. Baker remarked that the only way of producing alcohol at the present time is from some vegetable growth, and all that can be produced from the soil is required to feed the men and animals upon it. It is possible to use some waste products, e.g. waste molasses, to manufacture alcohol, but in comparison with the large volume that would be required for the supply of internal combustion engines, any such production is only a drop in the bucket. Mr. Baker also raised a question as to the exact amount of tar that can be produced from a ton of coal. This, according to the speaker, is an important matter, because coal tar is a smokeless fuel that might help to conserve the fast diminishing supply of anthracite, and it is in that direction that a source of relief for our future oil production must be looked for.

E. Y. Sayer supplied the information desired by stating that in this country 10 gal. of tar oil are obtained per ton of coal of 2000 lb. A member stated in this connection that where the production of tar is the main purpose of the operation, an even larger production has been secured by means of special processes, such as distillation at low temperatures, etc.

CEMENT MANUFACTURE

During the Annual Meeting of the Society one of the sessions on December 5 was given over to the discussion of the following papers contributed by the Sub-Committee on Cement Manufacture: Some Remarks on the Depreciation Factor in the Cost of Producing Portland Cement, Frederick H. Lewis; The Prevention of Missed Fires in Blasting, W. H. Mason; The Deterioration and Spontaneous Combustion of Gas Coal, Perry Barker. These, together with the discussion, are presented herewith. Certain of the closures are yet to be prepared.

SOME REMARKS ON THE DEPRECIATION FACTOR IN THE COST OF PRODUCING PORTLAND CEMENT

By Frederick H. Lewis, Birmingham, Ala.

Member of the Society

At the moment the question of the depreciation factor in the cost of producing portland cement is commercial rather than technical. Its urgent importance as a business proposition overshadows its scientific interest. The manufacturers of cement have so notably failed to define the cost of production, that few of them have a surplus or depreciation fund of any kind to deal with. In recent years numerous plants have yielded returns little if any greater than bare factory cost, and the commercial rating of the industry as a whole has suffered. The value which a technical discussion of depreciation may have, therefore, will consist chiefly in defining for the commercial end of the business the elements which should be considered to make up a satisfactory price for a barrel of cement.

2 The portland cement industry in America is but 37 years old. The first factory was built at Coplay, Pa., in 1875. This plant grew to considerable size and importance during the 25

The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

years ending in 1900. But during the latter part of this period units of considerable size were one by one discarded as having reached the limit of their useful life. The early developments of the American, Atlas, Alpha and Lawrence companies were similarly discarded. It is the writer's judgment, based on personal observation only, that the average useful life of plant units discarded in this way did not exceed 10 years, and that it must have required 15 to 20 cents per bbl. to cover the depreciation factor. Fortunately at that time prices carried an adequate margin of profit.

3 It is quite likely that present plant is more nearly standardized and that it may suffer less from obsolescence. But this is not certain; and the simple fact is that we have no sufficient experience to justify this conclusion. The development of production has been so rapid during the seventeen years just past, that if we assume increased output to be directly represented by the new plant (which is not strictly true), then we shall find that the average age of the plant units which will produce this year's output is seven years. We have then no sufficient industrial history to establish our data. We are forced to exercise our best judgment.

4 Fifteen years ago an English manufacturer stated to the writer that the repair cost in the manufacture of cement would average six pence per bbl. (12 cents). Subsequent experience verified this to be a reliable estimate. Today the figure is probably nearer 15 cents because the mechanical equipment has been much elaborated in recent years. If it is assumed that the necessary capital required is $1.50 per bbl. of annual output, then the ordinary repairs in the manufacture of cement amount each year to 10 per cent of the entire investment. This is not depreciation; it has nothing directly to do with depreciation. It is ordinary repairs. Depreciation "is the necessary annual installment of the annuity which will amount to the first cost of the property at the expiration of its useful life." The cost of ordinary repairs is merely the first factor to be considered in estimating the useful life of the plant. The high cost of repairs indicates rapid depreciation, or a short useful life.

5 The second factor to be considered is obsolescence—that form of depreciation due to improvements in methods or in machines which makes it necessary to modify plant and scrap

machinery which is still in good running order. As already indicated we have little data in regard to this. It may be accepted as definitely true, however, that few plants could be successfully operated today with the equipment and arrangement they had ten years ago. The very few which might make such a claim, can do so only because either by chance, or by reason of greater foresight, they happened to be designed along the lines which later progress has followed. Plants which are now ten years old or more and which are still operated, have generally had large expenditures put into them for enlargements and for improvements in details; and in spite of this are operating at some disadvantage by reason of obsolete machinery. Kilns and power plants in particular have changed notably in design, and the economy of heavier machinery, and of labor-saving equipment has continually claimed recognition. Enlargements and modifications of plant have more often been forced upon manufacturers than desired by them. Enlargement beyond a certain point is no longer desirable, but has frequently been accepted as the only alternative to closing down the plant. Such forced enlargements represent, therefore, in considerable part, depreciation pure and simple, the gradual replacement of an obsolete plant which will be as gradually discarded. Yet the cost has in most cases been paid for out of new capital. The writer has not sufficient data to be able to express an opinion on the cost due to obsolescence during the period from 1900 to January 1, 1912. No one familiar with the facts will doubt that it has been large.

6 A third factor to be considered in estimating depreciation is loss of profits due to shutdowns for repairs and renewals. This is often a considerable sum, by reason of repair periods extending over three, four, or even six months. If there is no surplus fund to carry interest and overhead charges during such periods, then the business has not fully provided for the expenses due to depreciation.

7 There are then three principal factors to be considered in estimating a depreciation factor: (*a*) wear and tear; (*b*) obsolescence; and (*c*) the carrying charges during repairs.

8 The ordinary procedure of cement plants is to limit their cost data to a monthly cost sheet. This deals simply with factory cost and usually, and quite properly, with only a part of the factory cost. The real and only useful purpose of these monthly cost sheets is to enable operating officers to institute

comparisons, locate leaks, and cut down regular operating cost items. Unfortunately, and quite generally, the cement people have made the serious commercial blunder of regarding these factory cost sheets as really representing the cost to be kept in view when making prices. An immense industry has been rendered unremunerative for five years past by this unfortunate blunder.

9 A factory cost sheet to be useful for comparison of cost items from month to month and from year to year, should exclude all occasional or extraordinary expenditures. If items of this character were introduced at random as they occurred, the value of the cost sheet would be destroyed. Such occasional or extraordinary expenditures, which are really depreciation charges, must be provided for annually by appropriating a sum for plant renewals to be accounted for separately from the cost sheet. This appropriation can be an arbitrary one, or may vary from time to time as the superintendent's report may indicate the renewal requirements.

10 It is to be remarked here that it is usual to deal with depreciation as an annuity payment at compound interest. The propriety of figuring the annuity at compound interest for cement plants is open to question. A cement plant is not at all like the one horse shay which went to pieces all at once, and nothing first. On the contrary there must be a considerable annual depreciation fund for immediate use, and which can have no interest accumulation. Not to gainsay an accepted method, depreciation should be provided for in two items: (*a*) an annual plant renewal charge, and (*b*) a depreciation charge. The accounts of the U. S. Steel Corporation follow this method. There is a regular depreciation fund which is 3 per cent of gross earnings, and a construction or plant renewal fund of an approximately equal amount, but which varies more or less as earnings vary.

11 Coming then to a method of figuring depreciation, let us make the following assumptions:

a Net capital investment = \$1.50 per bbl. of annual output, or 1.5 cents per bbl. = 1 per cent return on the capital.

b True depreciation to be based upon 25 years' useful life at 4 per cent compound interest. This equals 2.4 per cent per annum or 3.6 cents per bbl. of cement.

c Plant renewal to be based on 25 years' useful life, but without interest accumulation. This equals 4 per cent per annum, or 6 cents per bbl. of cement.

This basis assumes that each of the several items of the plant will be renewed once in 25 years, and that at the end of this period of 25 years the entire plant will have reached the end of its useful life. The writer is prepared to agree that this basis is low. But if the general argument is good, then the figures may be modified by exchange of views and data.

12 Assuming a factory cost of 60 cents per bbl., a remunerative selling price would then be estimated about as follows:

	Cents per Bbl.
(*a*) Factory cost including all ordinary repairs	60.0
(*b*) Depreciation fund	3.6
(*c*) Plant renewal fund	6.0
(*d*) Administration and selling expense, say	10.0
(*e*) Interest at 6 per cent on investment	9.0
Selling price	88.6

It will require about 90 cents per bbl. to come out even in this assumed case. It will require a higher average price if the business is to have a credit balance outside of depreciation.

13 On some such basis as this any manufacturer can estimate a safe selling price, using the actual facts of his own books for capitalization, factory cost, administration and selling expense, etc. If this is done most manufacturers will find that current prices have been too low in recent years, and still are so; many will find that an excessive capitalization must be scaled down if the business is to continue. And some will find themselves facing conditions which make it impossible to continue the industry.

DEPRECIATION AND OBSOLESCENCE IN PORTLAND CEMENT PLANTS

By H. Struckmann, Kansas City, Mo.

Member of the Society

To arrive at a fair percentage to be charged for depreciation, it is necessary to determine the probable average life of the machinery and buildings; this, however, is very difficult as in all cases there is a great deal of variation in the type of machinery and the character of material to be handled; furthermore, the rapid development of the industry has made it necessary to make continued changes and improvements in the plants and as a matter of fact has caused the depreciation, due to obsolescence to be greater than depreciation due to wear and tear.

2 The argument is heard quite frequently that if a machine is maintained in a state of efficiency by constant repairs and renewals of parts it does not depreciate so long as it does the work and that it is just as valuable when 10 or 20 years old as it was when new. The argument is wrong, however, as machinery does grow obsolete and cannot be made modern by repairs and renewals.

3 It is absolutely necessary to create a fund equal to the amount of the depreciation made from year to year and to be kept intact for the purpose of replacing the machinery and buildings at the end of their "life," and this provision should be made without any reference to profits or losses of trade, as depreciation for wear and tear and also obsolescence is a part of the working expense of a business.

4 The practice of showing so-called profits by accountants,

Extracts from a paper presented at the Annual Meeting, December 1911, and brought up for further discussion at the Annual Meeting, December 1912, of The American Society of Mechanical Engineers, 29 West 39th Street, New York. All papers are subject to revision.

out of which they create a depreciation reserve, without creating a fund as an offset, is dangerous, first, in that as a rule the amount of such depreciation is based upon the amount of the so-called profit, and secondly, in that it is wrong to make depreciation a charge on profits, as depreciation is positively a loss of the capital assets and should be made good out of the income or earnings, and finally, in that depreciation is as much a charge against revenue as material, labor, supplies, taxes, insurance, etc. The amount of depreciation should be determined without reference to the result of trading and must be considered as a charge in order that depreciation will represent the loss of value which occurs whether a business is conducted profitably or not.

5 The danger in not providing adequately for depreciation and particularly of basing it on the year's trading, is, that in bad years the amount which should be set aside for depreciation is paid out in dividends, which means in reality that dividends are paid out of the capital, a procedure followed as a rule with a view of better times coming when matters can right themselves; nevertheless this practice is always dangerous and invariably proves disastrous, as might be expected.

6 A large percentage of the cement mills of this country today are equipped with machinery which is out of date and is a serious handicap, but as provision has been made by hardly any of the manufacturers to replace their machinery, they must continue to operate old, and in some cases, obsolete machinery. Where the capital stock is raised for this purpose the new machinery quite frequently has to produce sufficient profits to pay interest on the lost capital as well as on the increased capitalization.

7 Over-valued machinery is a serious drawback to an operator in that if depreciation is properly applied it strikes at, and increases the producing cost by being burdened with more depreciation than should be applied if values were kept at the right figure, and from a financial standpoint this practice is most dangerous, so to be brief, depreciation must be defined as a loss in value which may be due to use, age or obsolescence, or a combination of these with several contributory causes and in a cement factory the amount of depreciation is the measure of loss in invested capital.

8 This may be called by some a pessimistic view, but in case of error it is error on the right side, as there is always the ele-

ment of unforseen contingencies which may happen at any time and for which a high rate of depreciation always serves as the best and safest plan of self-insurance for the manufacturer.

DISCUSSION

G. S. Brown[1]. There is bound to be a difference of opinion on the question of depreciation. Mr. Struckmann in his paper has taken the position that there should be a depreciation fund created in connection with portland cement plants. As to the correctness of this position as far as the ordinary manufacturing plant is concerned, there can not, it seems to me, be any question.

A cement plant, however, where both buildings and machinery are subjected to a very heavy wear, should be considered, from a very different standpoint than the ordinary plant where repairs are light and buildings are likely to last almost indefinitely. In the latter case any items of repair must of necessity come at long periods, while in a going cement plant the item of repair is continually before us, and it seems useless to consider a definite percentage of the original cost as a measure of the depreciation. The bulk of the investment in a cement plant is in the machinery, and one authority says: "If repairs are made so as to preserve machinery in first-class condition so that the work performed is of the same quality as when machinery is new, it does not seem equitable to charge off a percentage for depreciation."

This exactly describes the condition which must obtain in a cement plant if its output and cost are to be kept satisfactorily. Certainly no cement plant can compete today if the machinery in it is not kept in topnotch condition. It is, I believe, the practice with most manufacturers to take care of this by charging regularly each month to the cost of manufacturing all expenditures for the upkeep of the machinery and buildings, and as long as this is done there should be no need of additional charge for depreciation.

In a plant with which I am well acquainted there are machines which have been in continuous service for the last 15 years. These machines today do more work than they did 15 years ago. As a matter of fact, however, there is probably not

[1] Alpha Portland Cement Co., Easton, Pa.

a single part of the original machine now in service; indeed many parts have been replaced several times annually. Nevertheless from the standpoint of an appraiser, the machine is quite as valuable as a new one. Instances which show how the necessity for keeping machinery up to its maximum precludes the need of a depreciation account, are by no means as rare as the average engineer may suppose; indeed there are few machines in a cement plant not entirely obsolete, of which a similar statement may not be made. We realize, of course, that in the event of a mill discontinuing operations then the value of the plant has depreciated enormously. Few companies, however, would be willing to carry a depreciation account on their books sufficient to reduce the value at which a going plant was carried to a sum which would represent its value in the event of its no longer being operated.

When, however, the question of obsolescence enters we have a very different condition, particularly in a business where there is as yet no standard practice and no standard machinery. Machinery considered modern today is obsolete tomorrow and the only possible way that a mill can keep in competitive condition is ruthlessly to dismantle machinery which has become obsolete and replace it with more economical modern machines. It hardly seems possible that so large a percentage of plants as Mr. Struckmann cites can be operating in the present condition of the industry with out-of-date machinery. If the statement is approximately justified by facts, we must expect a very large number of receiverships and bankruptcies in our industry within the next few years.

The question of how the expenditures for renewing obsolete machines and buildings shall be handled is no doubt a very difficult one to the average concern. The amounts involved are necessarily large and to charge the entire amount at once to the cost of manufacturing seems, at least from the operating standpoint, unjustifiable. Particularly is this so with those concerns where only a single plant is operated and where the charges for replacements of this sort run into a considerable amount of money within a very short period of time. To carry such expenditures in a capital account, however, will be very strongly opposed by modern accountants and our judgment coincides with this attitude.

The fact that charging such expenditures to the cost of manu-

facture increases this item unreasonably and unjustly in particular months has led many corporations to put on their books accounts such as Improvement Account, Extension Account, Renewal Account, etc., with the result that ultimately the sum carried on the books as the value of the plant has been increased to an unwarranted degree. Some cement companies have a rule which requires that any expenditure for machinery or buildings which in any way replaces those heretofore in service, irrespective of whether the new machinery increases output or not, must be charged to repairs. When this rule is invariably followed the question of obsolescence must be satisfactorily cared for, although many experts will insist that an adjustment be made transferring a percentage of the expenditures to capital to equate for any increase of output or decrease of cost. The above method is open to the same serious criticism that it increases the cost abnormally at certain times and does not give a fair opportunity to compare them from month to month.

It has always seemed to me that the most reasonable method for handling the replacement of obsolete machinery is to have a certain specific charge made monthly to the manufacturing account against every barrel of cement manufactured, this charge to be more than sufficient to take care of, in the course of a year, those expenditures which experience has proved must be made annually in order to replace machinery which has become out of date. Against the fund which would be derived from this course would be charged all expenditures for renewals, and in this way the result obtained would be exactly the same as if all such charges were originally made to the manufacturing account. The effect would be, however, to distribute these charges more uniformly throughout the year, and give a very much more satisfactory cost for the purpose of comparison. Any system of accounting, however, which considers any portion of the repairs, or the expenditures for the replacement of obsolete machinery and buildings as capital expenditure, will ultimately cause trouble for those who manage the concern. I know of no plant where the method of handling expenditures for renewals just outlined is being followed, but feel sure that it would be more satisfactory than any other of which I have any knowledge.

As Mr. Struckmann has said, the question of the obsolescence of cement plants must be faced by every manufacturer of

cement, and any attempt to straddle the question will result only in a postponement of the day of reckoning.

Entirely apart from the mill proper, in every cement producing plant there is an item of depreciation which must be considered, and that is the depreciation of quarry. Many plants are so situated that this item can be entirely overlooked. The quantity of raw material at hand is so large that for practical purposes it may be considered unlimited. Other plants are situated, however, where the body of raw material is circumscribed, and in such places it is very necessary that a proper depreciation account should be opened to replace the raw material at the expiration of a certain fixed time.

R. K. Meade. At the plant of the Tidewater Portland Cement Company, Union Bridge, Md., all the machinery, including conveyors and elevators, is driven by individual motors. The central power plant consists of three 23 by 46 by 48 in. compound condensing Corliss engines made by the Wisconsin Engine Company, and direct connected to General Electric 800-kw. generators supplying 3-phase current at 550 volts and 25 cycles; a reserve 150-kw. unit is also at hand. A frequency meter is installed to control the cycles and by them the speed of the mills. To control the efficiency of the power plant independently of that of the whole system, a recording meter is installed and, in combination with automatic coal scales, gives all the information required.

Throughout the mill itself recording watt-meters are installed in the various departments. This allows a record to be kept of the power used in each department. Readings of these are taken twice a day, with the change of shifts, and any unusual rise in power per barrel in the department is looked into at once. This results in low power consumption because as soon as a rise occurs, it is instantly traced to its source. When the mill was first started, a great deal of trouble was experienced with the motor drives. Most of this was due to faulty arrangement. In some cases, the motors were much too small for the load on them, and in others, large motors were pulling very light loads. The result was that the large motors were running at a very low load factor and the small motors were giving a great deal of trouble from overheating and even burning out. In order to remedy the trouble a test was made of every motor on the plant when operating under normal conditions, and, as the result of this test, a re-

distribution of the motors was made, and in all about 40 motors were changed. Much of the trouble with the motor drives was thus eliminated. In changing from a line drive to a motor drive and in installing a motor drive in a new plant, much thought should be given to the size of motors employed. When the Tidewater was built very little information was available relative to the horsepower required by conveyors and elevators operating in cement mills and most of the locating was done by guess rather than by science. Manufacturers generally are apt to underestimate the power required by their machinery. At the same time, if too liberal allowances are made over their figures, and motors much too large are employed, the result will be a low load factor, and the need of additional generating machinery in the power plant or the use of a few synchronous motors about the plant.

One objection to the employment of small individual motors for a group of elevators and conveyors is that the small motors are likely to stall from an overloaded conveyor or elevator, while with the larger motor the surplus power is sufficient to overcome this overload. This point against the individual drive, however, is to my mind, more than offset by the absence of belting and countershafts in the mill.

At the Tidewater plant, the conveyors and elevators are all driven by back geared motors of the squirrel cage type and the writer's experience with these extends to motors up to 30 h.p. The gears and pinions after a year's service show almost no wear. The gears are encased in a dustproof gear case, which is partly filled with a cheap grade of heavy oil. The power is transmitted from the motor to the conveyor or elevator by means of a sprocket and chain.

The Fuller mills at Tidewater are all driven by vertical motors. The 42-in. mills are driven on the raw side and in the coal mills by 75-h.p. motors and the 54-in. "Dreadnaughts," on the clinker side, by 200-h.p. motors. The 200-h.p. motors were the first vertical motors of this size ever built and at first gave some trouble because of improper lubrication, which has been remedied. Experience has shown that it is far superior to the old quarter twist belt formerly employed with mills of the Fuller-Lehigh and Griffin types.

At Tidewater the motors driving the Fuller mills are installed with indicating ammeters which are placed in full view

of the mill attendant and when the indicator on the ammeters to the 200-h.p. motors points to 175 amperes, the attendant cuts off the feed to the mill and so avoids a choking of the latter.

A compressed air line runs from the compressor in the quarry to the mill, with branches to various departments. This is used for blowing out the rotors which are for this purpose lifted out of the motors by means of an overhead trolley and chain block. The motors are protected by no-voltage and overload relays.

The system followed at Tidewater of taking care of the motors is as follows:

The motors are in charge of men appointed for that purpose and known as "motor-men." It is their duty to start all motors after a shutdown for repairs or for a choke in the mills or elevators. This avoids burn-outs. They also make thermometer readings of every motor once a day and inspect the motors hourly. At the end of the day, they make a written report of the condition of each and every motor in the plant and advise what repairs, if any, are necessary. They also give the number of hours each motor was in operation during the shift and report on all shutdowns, stating whether these were due to the motors or to the machines they were driving.

This enables an exact history of each motor to be kept and for this purpose each is given a number, starting with zero. All records are kept in a special ledger known as the "motor ledger," a page being devoted to each motor. At the head is placed the plant number and the figures obtained from the manufacturer's name plate as to type, rating and shop serial number. Any repairs are charged on this page and at any time an exact figure as to the cost of upkeep of any motor can be obtained from this ledger.

Table 1 gives a list of the motors at the plant of the Tidewater Portland Cement Company, as arranged, September 15, 1912.

TABLE 1 MOTORS, TIDEWATER PORTLAND CEMENT COMPANY
AS NOW ARRANGED FOR 300 BBL. DAILY CAPACITY

MACHINE	MOTOR, H.P.
Air compressor	100
Incline chain hoist for cars	22
Car dump	12
Limestone crusher, No. 9, gates	150
Limestone crusher (2) No. 6, gates	50
Pan conveyor from the above, back geared	5
Elevator from above to dryer stock boxes	20

TABLE 1—Continued

Machine	Motor, H. P.
Belt conveyor from above to stone storage, back geared	5
Belt conveyor from limestone storage, back geared	5
Shale crusher, No. 6, gates	50
Pan conveyor from above, back geared	10
Elevator from above to stock boxes above dryer, back geared	15
Screw conveyor above dryer stock boxes, back geared	10
Belt conveyor to shale storage, back geared	5
Belt conveyor from shale storage, back geared	5
Limestone dryer 7 ft. in diameter, and 50 ft. long	30
Shale dryer 7 ft. in diameter and 50 ft. long	15
McCaslin conveyor, limestone, back geared	10
McCaslin conveyor, shale, back geared	10
Ball mills, Krupp No. 8 (3)	50
Elevator from two limestone ball mills to mix bins, back geared	20
Elevator from shale ball mill to mix bins, back geared	10
Screw conveyor from mixing bins to scale, back geared	10
Screw conveyor from mixing scales to elevator, back geared	10
Elevator from above to the pulverizer stock boxes, back geared	10
Fuller mills, 42 in. (8) raw materials, vertical (8)	75
Fuller mills, 54 in. (2) raw materials, vertical (2)	200
Screw conveyor from mills, back geared	5
Rotary coolers, 5ft. diameter and 40 ft. long, back geared	10
Screw conveyor over pulverized bins, back geared	10
Screw conveyor from kiln stack dust chambers, back geared	5
Fans, motors are direct connected, high speed	10
Screw conveyors feeding pulverized coal to burners, back geared	2
Kilns, 8 ft. in diameter and 125 ft. long, variable speed	30
Rotary coolers, 5 ft. diameter and 40 ft. long, back geared	10
Inclined pan conveyors from kilns, back geared	5
Belt conveyor from above, back geared	5
Elevator from above, back geared	10
Belt conveyor from clinker storage, back geared	7½
Belt conveyor under clinker storage, back geared	10
Bucket elevator from gypsum, back geared	5
Elevator from clinker and gypsum scales, back geared	20
Fuller mills, 54 in. clinker (10), vertical	200
Screw conveyor from below to bins in stock house, back geared	10
Belt conveyor to stock house, back geared	10
Screw conveyor from bins, back geared	30
Elevator from above to packing machine boxes	7½
Bates valve baggers (two on one motor)	30
Bag tying machine	2
Belt under coal trestle, back geared	30
Crushing rolls and elevator from above, back geared	5
Ruggles-Coles dryer, coal, back geared	7½
Elevator from dryers, back geared	7½
Meade dryer, coal	10

TABLE 1—Continued

Machine	Motor, H. P.
Fuller mills, 42 in. coal (3), vertical	75
Elevator and conveyor from above, back geared	10
Coal tunnel at power house conveyor, back geared	5
Elevator from above, back geared	7½
Drag conveyor from above, back geared	10
Stokers in boiler room (all on one motor), back geared	10
Machine shop (entire equipment)	15
Bag cleaning wheel	15
Motor driven exciter	150
Hydrated lime plant (entire equipment)	100

R. C. Carpenter stated that he made a very careful study of many of the points in this paper. The percentages of selling price as figured out, is practically 50 per cent more than the manufacturing cost. He does not believe that there are many manufacturers outside of the cement industry that can ever make money with a selling price not more than 50 per cent greater than the cost of production. That percentage seems to be a very low amount for overhead charges, administration, interest and depreciation. If what Mr. Lewis states is correct, the earnings in the cement industry do not look so unfavorable as compared with other industries. Professor Carpenter has found that in proportion to the amount invested in the business the net earnings of the cement plants were smaller than could be found in a good many industries. This seems to indicate that there has been a very great competition in the cement industry, and that prices have been as a whole too low. Of course for a few years mills may be operated, although the returns may be small, but in the long run the capital invested in any industry whatever must receive a certain net return. The speaker's investigation rather indicates that for the last few years in the cement industry the returns have not been adequate for the investment; he believes that it is fair to the producer that prices should be raised, and thinks that they could be raised without affecting the demand.

As to obsolescence, the speaker pointed out that in the cement industry, grinding machinery, for instance, had a remarkably long life, both in view of the time that it has been kept in use, and of the improvements in that kind of machines. In regard to kilns there has been a very great change due to improvements in the last few years. On the whole he is more in accord with Mr. Browne in his discussion than with Mr. Lewis. The grinding mills have a long life, but to keep the machines in running order a large and constant repair account is necessary. His im-

portant question is whether this large repair account should properly be charged to depreciation, or to the operation of the plant. Professor Carpenter thought that the proper way to find the true depreciation was to ascertain whether the amount charged for that purpose made the capital account really different from its true valuation. If the plant becomes of less value year by year, and there is no money to cover this loss, then there is a depreciation which has not been taken account of.

There should be an increase in cash corresponding to the loss in value, if the depreciation is taken care of, and if the value of the plant is not kept up to the original cost. The depreciation may be accounted for, as Mr. Browne states, by an actual charge per barrel against manufacturing cost.

R. K. Meade raised the question of the relation between the sinking fund and depreciation account; if a plant is built with bonds, and charges off every year for sinking fund, should it maintain also a depreciation fund? As regards the question of obsolescence with particular regard to the cement industry, then one had to do more with the problem of turning out cement in very much larger quantities than with actual changes of process. In some cases, especially in the West, the question of the supply of raw material, particularly limestone, is also of importance.

P. H. Wilson[1] claimed that Mr. Lewis was wrong in stating that the net capital invested is only $1.50 per bbl. In most cement mills in the United States it runs between $2 and $3 per bbl., and if his calculations are taken on the basis of $2.50, there will be added considerably more than 50 per cent to the net cost of depreciation and of selling a barrel of cement. As to interest, Mr. Lewis estimated it at 6 per cent on the investment. The figures should be pretty nearly doubled, with exception of the administration or selling expenses, which are not affected by the capitalization of a mill to prove an attractive investment.

A few years ago Mr. Mallory made up some interesting figures on the cement industry in the United States, and found that this industry turned its capital over at a less rapid rate than any other industry in the United States. It takes the cement man about three years of actual work to turn over his capital and therefore, instead of the interest being charged at a flat rate, it should be increased to cover the fact that the capital is turned over so slowly.

Joseph Brobston explained that while the amount of stocks

[1] Secy., Amer. Portland Cement Mfgs., Land Title Bldg., Phila., Pa.

or bonds issued on a plant may be $2 or $3, the amount of money really invested per barrel is very conservatively estimated by Mr. Lewis at $1.50, the great trouble with the industry being that in many cases plants have $2 or $3 per barrel capitalization, due to the fact nothing has been charged off for depreciation, and all replacements of machinery have been added to the capitalization. If a sinking fund were maintained, as suggested by Mr. Meade, that would take care of a part of the depreciation charge, and by the time it was necessary to replace the machinery, the bonded obligation would be reduced to such an extent that more money could be obtained without over-capitalization. Ten cents per barrel should cover both depreciation and obsolescence, but at that figure the machinery would have to be kept in good order all the time, with the repairs being charged into the monthly cost.

To arrive at a proper depreciation charge one should start in at the quarry. There are some plants where the cost of replacing their stone would be practically a negligible item, but a great many companies have a limited supply, and these companies should charge off the amount it would cost to replace it, and not what the land originally cost. The next step is to have competent builders determine what the depreciation should be on the class of buildings in the plant. Figures for the depreciation of the engines, boilers and motors could be easily secured; the actual depreciation on the latter could not be included in the monthly charge for repairs because the motors go on without much repairing until they are thrown out entirely. There is probably a good deal of depreciation in the kiln room. The speaker thinks that a 6 by 60 ft. kiln would be rather a handicap today, the 8 by 125 probably being better adapted to the present economic conditions.

Mr. Wilson stated that although some cement manufacturers are beginning to use concrete and reinforced concrete in their mill buildings, the increase in sizes of the newer plants have come so rapidly that there is a tendency not to use material of too permanent a character, and this may be expected to continue for the next five or six years, because the economic size of the kiln and the life of the grinding machines are not absolutely fixed at the present time, and perhaps will not be for some five or six years to come. But wherever they have put in storage houses, reinforced concrete was used almost entirely.

A very important point brought out by Mr. Meade is that

power at the Tidewater plant is generated at far less than half a cent. The cheapest price of power in the Lehigh Valley is about a third more. How long a plant can continue to generate power at $33^1/_3$ per cent more than another plant and do business, the speaker did not profess to know.

F. W. KELLEY supported the suggestion that if different manufacturers compared notes, they could get some definite figures on depreciation, and spoke of the work being done by the Society in the appointment of sub-committees on industry. The Sub-Committee on Cement Manufacture is endeavoring to secure information from other sub-committees of the Society on the depreciation and obsolescence of the various machinery entering into power plants, electric motors, lineshafts, pulleys, wiring, etc. Thus far no data have been received, but when they come, they will probably be of great value.

R. C. CARPENTER commented on the remarkably low result obtained by Mr. Meade, of 3.3 lb. of coal per kw-hr., as showing exceedingly good management as well as the use of the best kind of machinery. A 5000-kw. turbine which he had investigated some time ago had given a result of 2 lb. of coal per kw-hr. with West Virginia coal. This was thought to be a record result at the time, although higher economy has since been obtained. As the load changed, however, the economy changed very materially in that test, and as the load varied from the best, more coal per kw-hr. was used. This result indicated that Mr. Meade had his turbine running with about the best load and that his transmission losses were exceedingly small. Generally the cement industry presents opportunities to get high economy, as machines can be run at practically a constant as well as full load.

E. Y. SAYER called attention to the advantages of standardizing the motors used in cement mills, by having the motors go in units of 5, 10, 25 and 50, in order to facilitate repairs. He also highly commended the system used in the plant described by Mr. Meade, viz., an assignment of special men to look after motors, daily records and reports on each motor, special men for starting motors, etc.

H. STRUCKMANN. Mr. Lewis' remarks on depreciation in cement plants are very apropos at the present time. Even in territories where an actual cement shortage exists, prices are kept at a ruinous level, the only explanation for which is that the manufacturers, as Mr. Lewis states, have failed to define all of the items entering into the cost of producing portland cement.

At a recent meeting of the Association of American Portland Cement Manufacturers, the writer brought up the question of proper depreciation charges, and suggested a minimum of 0.10 per barrel, which, according to Mr. Lewis' views would be equivalent to about 7 per cent of the capital invested in the plants. The fact that the current repair charges in a cement plant amounts to between 20 and 25 per cent of the total manufacturing cost, indicates clearly that the depreciation going on is considerably higher than in the average industrial plant, and that if anything, 7 per cent on the invested capital, or 10 cents a barrel is too low a charge to cover depreciation.

The following classifications of depreciation charges, which are adopted in the plants with which the writer is connected, may be of interest:

	Per Cent of Reproductive Value
Factory buildings	5
Factory machinery	12
Power plant equipment	10
Electric light system	7
Railway tracks	7
Quarry rails and equipment	15
Tools and fixtures	10
General construction, fences, retaining walls, etc	7
Water works and pipelines	10
Oil storage tanks	7
Dwellings	5

The above various percentages represent on the basis of capital invested per barrel output, as outlined by Mr. Lewis, approximately a flat rate of 15 cents per barrel, and the writer's experience has shown that it is none too heavy a charge if the investors in portland cement plants are to be protected.

Mr. Lewis' statement that carrying charges during shutdowns of the plant on acount of repairs are properly chargeable to the depreciation fund, in the writer's opinion, is not correct. Interest, overhead, as well as other carrying charges of similar nature, have nothing to do whatever with depreciation and should be taken care of not by the depreciation reserve fund, but by a contingent reserve fund, created not only to take care of the above items but also to cover charges accruing while the plant is idle on account of the market conditions, as well as extraordinary accidents like explosions, floods or other causes beyond control.

THE PREVENTION OF MISSED FIRES IN BLASTING

By W. H. Mason, Stewartsville, N. J.

Member of the Society

A frequent cause of serious accidents in cement manufacture is the explosives used in the quarries. Many of these are due to what is commonly called "missed fires," that is, bore holes which have been loaded with explosives and which fail to explode when detonated. Formerly when the holes were exploded by time fuses this was probably more frequent than at present, when it is common practice to explode a series of holes by an electric battery, fuses being used only to explode the small "plug holes" or dobies, for the purpose of breaking large stone which has already been blasted from the ledge.

2 A "missed fire" is always a source of danger. There is no known way of unloading it safely and when an attempt is made to drill another hole near it, so as to blast it out, the drill bit not infrequently comes in contact with the dynamite in the loaded hole with disastrous results to the driller. When the driller is fortunate enough to get his hole in without accident, it is loaded and blasted. This usually throws the powder from the "missed fire" hole among the debris and frequently when the latter is being loaded, a laborer will strike it with some tool and cause an explosion. The only way to avoid this danger is to prevent the missed fires. Newspaper clippings collected by the Du Pont de Nemours Powder Company show that there were 59 people killed and 157 injured in the United States in the last three years, due to missed fires.

3 For about eight years the Edison Portland Cement Company have been exploding all churn drill blast holes with a 500-volt direct-current power circuit. Many of these blasts are

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made of from 12 to 20 holes, each loaded with 500 to 800 lb. of 40 and 50 per cent gelatine powder, and during this time there has been only one missed fire hole. It was impossible to find the cause of this failure, but it was attributed to a poor connection from the exploder leads to the bus wires. Before this time, they had been using the common push-down batteries and it was a usual thing to have several missed fire holes per month.

4 One of the quarries of the company is so located that no power circuit is available. For a year or two the blasts were set off by push-down batteries. After having had several missed fire holes, and some resulting accidents, they installed a small 250-volt direct-current generator, driven by a steam turbine. This has been in operation several years and there have been no missed fires since its installation.

5 Gelatine powder is the most difficult of all the dynamites to detonate and it is a well-known fact that if exploded by a powerful detonator, the full effect of the powder is obtained, while if improperly detonated, much of the effect is lost. For this reason and also on account of the danger and expense which always accompany a missed fire hole, the writer believes it is well to use too many exploders, or electric fuses, of high power than not enough. In a 6-in. bore hole, running 60 ft. deep, not less than three exploders should be used. One of these should be directly at the bottom, so that if when loading the hole with dynamite, a stone should slide in from the side and block it off, it would still be possible to explode the dynamite below, and thereby avoid the danger from the otherwise unexploded dynamite; the other two are distributed one near the center and the other near the top. All are connected directly across the 500-volt or 250-volt direct-current line, so that all exploders are in parallel and receive the full voltage of the power circuit. By this method any number of holes may be exploded at one time.

6 The cost of the extra exploders is always a small proportion of the cost of the dynamite used and the writer believes that this expense is warranted by the increased detonation power of the exploder, as well as by a sort of insurance against missed fires, which are always expensive aside from their potential danger.

7 Fig. 1 shows the method of connecting the wires of the electric fuses to the bus wires. The argument has been advanced

frequently that the insulation on the leads of the electric fuses is not sufficient to withstand the high voltage. This, no doubt, is true, but experience shows the fuse in the exploder blows

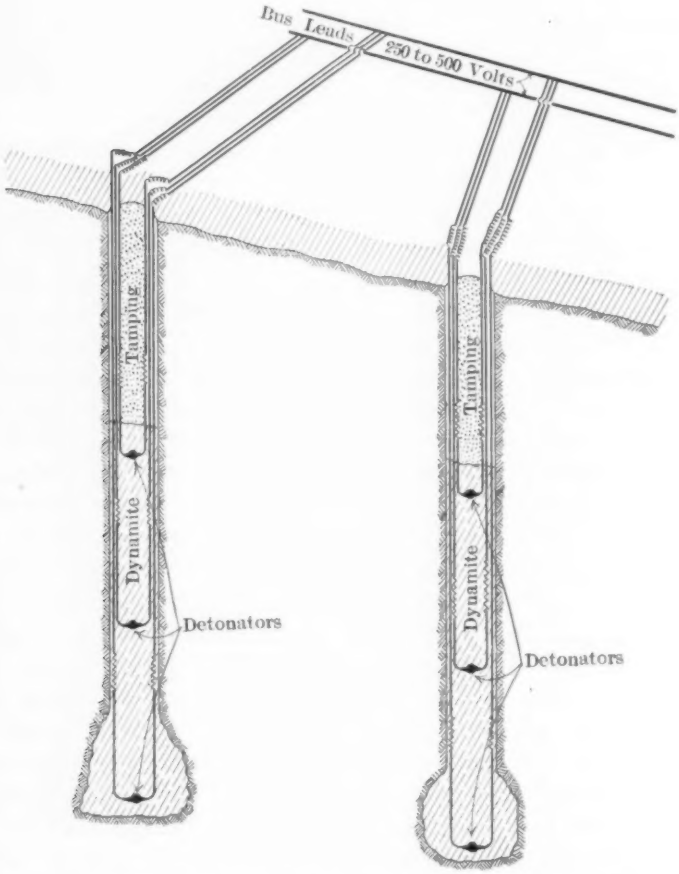

FIG. 1 SHOWING EXPLODER LEADS AND CONNECTIONS TO BUS WIRES

while the insulation is breaking down, and it is then a matter of no importance whether the insulation fails or not.

THE DETERIORATION AND SPONTANEOUS COMBUSTION OF GAS COAL

By Perry Barker, Boston, Mass.

Junior Member of the Society

In the storage of coal for use in cement manufacture the risk due to spontaneous combustion must receive serious consideration. Spontaneous combustion is caused by slow oxidation, principally of carbon compounds in an air supply, which is sufficient to support the process of oxidation but not sufficient to remove entirely the heat thus produced. The majority of cement manufacturers use gas coal slack for burning, having an average analysis as follows:

Moisture	3.00
Volatile matter	33.50
Fixed Carbon	55.50
Ash	8.00
	100.00
Sulphur	1.50

2 While the amount or composition of the volatile constituents of coal, or of the percentage of sulphur, give no direct indication of the liability to spontaneous combustion, fuels of this type have been known in a number of cases to heat in storage to such an extent that ignition and serious damage due to fires have resulted. The total loss of heat value due to storage without spontaneous combustion is comparatively small. However, the results of deterioration which has proceeded to the ignition point are more serious, involving the change in the character of the coal due to loss in volatile matter, abnormal percentage of moisture contained in the fuel after quenching as a last resort, costs of moving the coal in an endeavor to arrest the spread of the fire after the coal has become heated

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in certain localities in the piles and financial loss from fires directly traceable to this cause.

3 A number of erroneous reports have been submitted as to the extent of loss in heating value due to the deterioration of coal exposed in storage. These reports contain various figures on the loss in heating value, ranging from 10 to 50 per cent. Some results of tests on German gas coals have been submitted which state that these fuels have sustained an average loss of 1.7 per cent of heating value per week.

4 The diverse nature of the data which have been published on this subject, together with the importance of the subject, have promoted extensive experiments by the U. S. Bureau of Mines, the Illinois State Engineering Experiment Station, and several private interests to determine the exact nature of the reactions involved and study methods for prevention. The processes of deterioration from which spontaneous combustion ultimately results may be best stated as follows:

a The escape of combustible gases when fresh surfaces of coal are exposed after removal from mine workings. Experiments on coals having the analysis described indicate that the loss of combustible gases in this manner is approximately equivalent to the volume of the coal. The heating value of these gases amounts to 0.1 to 0.2 per cent of the calorific value of the coal. The detrimental feature of this action does not lie in the small loss in fuel value but in the dangers incurred by the escape of inflammable gases in mines and the oxidation which accompanies the evolution of these gases.

b The absorption of oxygen from the air with consequent evolution of heat. This reaction is conceded to be the primary factor in the process of coal deterioration and production of heat in piles and is caused by the direct union of the oxygen of the atmosphere with unsaturated carbon compounds in the coal matter. Freshly mined coal is very susceptible to this reaction and absorbs oxygen with great avidity at the time of evolution of combustible gases.

c The size of coal, particularly of the type used for cement manufacture, is a primary factor in promoting deterioration. Fine coal brings larger surface ex-

posure in contact with the atmosphere and accelerates the process of oxidation in the entire mass.

d The presence of moisture in abnormal percentages, particularly if coal in storage is wet and dried alternately, accelerates the processes of absorption and oxidation. The extensive experiments by the Illinois State Engineering Experiment Station have shown that the activity of these reactions is increased by wetting the samples under test.

e External sources of heat, even though moderate in degree, tend to promote the reactions which produce spontaneous combustion. Heat produced by external sources may originate from contact with steam pipes, boiler walls or floors. This heat may also be traceable to the climatic conditions.

f The importance of the oxidation of sulphur compounds in the process of deterioration is a question of some contention among the authorities on this subject. Although the total heat evolved from this source is not large in comparison with that produced by the several sources noted above, it will undoubtedly promote to some extent the other reactions.

5 A number of experiments have been conducted upon high volatile American coals to determine the actual loss in heating value during storage, together with observations on the slacking or reduction in size produced by the deterioration. Universal opinion is now to the effect that such coals will lose from 1 to 3 per cent of their heating value in one year. A large percentage of this loss results within from three to six months after the coal is placed in storage. It is apparent that the loss in heating value is not the most serious consideration in the question of coal storage. However, the ultimate results of deterioration which has proceeded to the ignition point, although not determinable in financial units, demand that certain precautions be taken to prevent the procedure of this action to a point where ignition will result. The methods of prevention can best be divided into the following general headings:

a Elimination of combustible gases before storage.

b Storage in piles not over 10 or 12 ft. deep with maximum points the same distance from exterior of storage.

c The removal of fine coal so far as possible, storing only

the screened lump. If a mixture of lump and fine coal is stored the various sizes should be evenly distributed to prevent the formation of air passages through segregated portions of large sizes.

d Ventilation by pipes should not be attempted and the admission of air by infiltration through brick work or porous foundations should be prevented.

e Exposure to weather conditions, where the coal is subject to heavy rains and subsequent drying from the sun or other sources of external heating such as steam pipes or heated brick work, should be avoided.

f The elimination of heating by the prevention of action through submerged storage. The effect of a large percentage of moisture introduced by submerged storage has been materially lessened in a plant recently constructed in which coal is stored but partially submerged. It has been found that the exposed portion of the piles maintains a sufficiently high percentage of moisture through capillary attraction to prevent serious oxidation.

g Prevention of dangerous dust and gas explosions as well as spontaneous heating caused by the storage of powdered coal. Coal for burning clinker should be pulverized at the furnace doors and only at the rate required for immediate use.

6 While the extent of the loss in heating value through deterioration of high volatile American coals, such as are used in cement manufacture, may not be of serious importance, the heating effects of the reactions incident to this deterioration demand attention to the designing of coal storage and to the necessary procedure in arresting deterioration which has begun through lack of proper precautions.

DISCUSSION

E. Y. Sayer referred to a recent bulletin issued by the United States Government on the deterioration of gas coal and stated that the facts set forth in this bulletin indicated that the depreciation taking place in gas coal was very rapid at first, commencing immediately after the coal was first mined, but the rapidity of deterioration was greatly reduced as time went on, and after a year or so it became almost a fixed quantity.

If this is the case he thought that a great many companies were making a mistake by periodically or at frequent intervals using up their storage. It would seem that storage should be looked upon as merely a matter of insurance and that after a sufficient amount of coal had been placed in storage it should not be used until absolutely necessary to draw on it. Every time that coal is taken out of storage, we are simply pocketing the loss due to the early rapid depreciation; whereas, if the coal is allowed to remain in storage, this loss will be incurred only at long intervals of time.

The AUTHOR in answering Mr. Sayer's questions, stated that, if a pile starts to fire, the first alternative would undoubtedly be turning over, provided the combustion had not proceeded to such an extent that it was impossible to get close enough to the source of heat. He had found a number of pile fires where the coal had become incandescent, and there the only alternative was flooding. The method of using closely covered storages in order to prevent spontaneous combustion the speaker found to be a very dangerous one. A fairly large volume of CO_2 would be produced with the possibility that the process of heating would proceed to such an extent that large volumes of combustible gases would also be liberated, leading to explosions. He cited a case where fire was caused by closely covered storage. A pile of ten or twelve thousand tons of coal, of exactly the character now under consideration was placed in outside storage. Snow fell to the depth of say two or three inches and instead of leaving the coal which was already covered with snow open, the whole storage was covered closely with rough lumber, laid tight to the pile, and down to the ground, with the result that there was no ventilation whatever. The coal was wet, and serious fires started.

Another of Mr. Sayer's suggestions was that, from a commercial standpoint, storage should be looked upon as a matter of insurance. The stored coal should not be used up until it is absolutely necessary to draw on it, because the greatest deterioration takes place in the first few days after the coal is mined, and changing the coal in the storage often means simply pocketing the loss due to the yearly depreciation. Mr. Barker pointed out, however, that it is very dangerous to leave coal in storage for a great length of time. The two problems of deterioration and spontaneous combustion, while interdependent, are somewhat different. The loss in heat values may proceed rapidly in

freshly mined coal, and ultimately reach a minimum, but an action may have been started to such an extent that it will proceed violently with resulting ignition. Besides, as shown in the paper, there is depreciation in the actual gas making value of coal when placed in storage.

The question of moving coal which has reached a certain temperature is of great importance. A temperature of 140 to 150 deg. fahr. is considered sufficient cause for taking steps to move the coal, preferably digging a trench of such width and length that the source of the high temperature can readily be exposed without covering it with any fresh coal.

During the presentation of his paper, Mr. Barker referred to the subject of fires and described a method of determining the temperature at the interior of a pile by means of a ¾-in. auger containing a maximum thermometer. The auger is screwed to sections of iron rod of slightly smaller diameter and can be driven in the pile to a distance of about 20 ft. and it requires about 20 minutes to record a maximum temperature. The result with lump coal is not very successful, but with the Eastern Pennsylvania bituminous coals that come to the market it afforded a ready means for driving the thermometer to the source of the trouble.

In reply to a question, Mr. Barker stated that the possibility of the heat produced by frictional resistance in driving the auger into the coal affecting the amount registered by the thermometer had been fully considered. It seemed, however, to be a factor of little consequence, because the auger is driven at the rate of 20 ft. in two or three minutes. Mr. Sayer suggested that this question could be settled fully by inserting an auger in a pile of coal of which the temperature is precisely known; then the recording thermometer in the auger would show just what happens.

MISCELLANEOUS DISCUSSION

THE PRINCIPLES OF VALUING PROPERTY

By Henry K. Rowell, Published in The Journal for September 1912

ABSTRACT OF PAPER

The purpose of the paper is to bring out some of the fundamental principles involved in the valuation of property. The distinction is defined between the word value, and a valuable consideration, and the several purposes for which value is to be determined, each of which may vary from the other and still be within the truth. The commercial value is the one most essential to an industry and should be the determining factor for purposes of tax, insurance or sale.

No valuation can be properly ascertained without accounting for the depreciation.

Capitalization is a delicate and intricate question to deal with. The author's experience is that most if not all writers skip over this subject lightly, and he has yet to find a real logical discussion of the subject.

In all mechanical and industrial processes the same laws of growth and development are as potent as are the laws of evolution in the natural growth and development of the physical world.

DISCUSSION

Charles H. Fish. The question of the valuation of property, speaking particularly of manufacturing property, is one which, unfortunately, can be looked at from a number of points of view, all of which are more or less reasonable. The answer to an important question always asked as to the age of a machine, a group of machines, or a building, is apt to be misleading. There is a number of kinds of machines which have been but little improved upon during the past period of years, and on account of this slow advance in the state of the art, the age alone is of comparatively small importance. Again, the question as to how carefully or intelligently the repairs have been kept up is one that must be considered in determining the present

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value. To quote from Mr. Rowell, Par. 46, "The writer has known frames of about this age (15 years) to require such thorough fitting that the standards were about all that there were left to the original machine." In other words, when the repairs were finished, these frames had new roll stands, new rolls, new spindles and rings, or in fact all of the important operative parts of the machine had been renewed. Admitting that the design of these machines was good, as no doubt it was, did they not, by these repairs, practically wipe out 15 years of age with which these frames were charged, bringing them down somewhere near a new frame age?

At the same time, in a recent experience with an association of insurance companies, the writer found it very difficult to get them to depart from the old theory that all machines have a certain, more or less definite life, at the end of which they were practically dead and worth only their value as scrap, and following this theory, they claimed that a machine, the life of which was called 20 years, was half worn out at the end of ten years. There are many machines in textile mills that are of such design or their operation of such character, that their active life can, by intelligent repairs, be continued almost indefinitely. These machines may die at the end of 20 years if allowed to by neglecting repairs, but as a rule they are well, or at least fairly well, kept up. On the other hand, it is a fact that some machines are bound to wear out in spite of attempted repairs, or many become worthless owing to new improvements and inventions, but to state that the life of a machine or a building is a stated period of time, or that its value depreciates at a definite percentage per year, is very often wrong.

One of the principles of valuing property should be a careful detail investigation of each part or portion of the property in order to determine its actual physical condition and not to be guided too much by the one factor "age."

In reply Mr. Rowell said it was his intention to bring out here what might be called secondary depreciation. At the end of a period a machine, or group of machines, might be revived so as to be comparatively new, yet they were not as good as wholly new modern machines would be on account of improvements made in patterns, design, or what has been called advancement in the art.

C. J. H. Woodbury said that the distribution of power by

various types of porches following the open belt porch, was an important feature in depreciation of mill property. Porches enclosed by wood sheathing, followed by the type at the side of the building and others, in all of which power was distributed along the lines of belting, and finally the belt porch projecting into the mill by which the power was distributed along the lines of shafting, were an indirect source of depreciation. In new mills these forms of construction had been displaced by the electrical transmission of power, which did not require more than a provision for the conductors. The old mill buildings were depreciated by this subsequent electrical invention because these belt porches formed a portion of the structure and for reasons of strength could not be removed.

Thus the advent of the electrical transmission of power with its freedom from requiring structural provision in a mill hitherto necessary, had within a few years enabled engineers to design a mill solely as a manufacturing structure without making arrangements for belt porches, without their attendant expensive impediments to floor space and light, and this improvement has in like manner depreciated mills of earlier types of construction, independent of wear and tear.

There was a depreciation from the contingency of an abandonment of the site of the mill, especially as the result of a fire. In such a case the owners of a mill at a water power distant from a railroad might find it more advantageous to connect the power house to an electrical generating plant and carry the wires to another site along the line of a railroad, than to rebuild on the old site.

A saving in gas of $3000, or 6 per cent, on the cost of a mill, was revealed in the case of removal of the machinery to a new building having larger windows. In both instances the buildings were lighted by the town gas at the same rate and the identical meter was used. It would not generally be assumed that modern windows would depreciate a mill having old types of windows 6 per cent.

He said another form of the distribution of depreciation was that of insurance. He knew of one cotton mill which had been insured for a number of years, under the factory mutual insurance plan on the basis of paying gross premiums subject to returned dividends, which instead of being credited to the insurance account, were invested in the stock of the mill purchased on

the open market and in a few years a permanent insurance fund thereby secured, the income of which in the shape of dividends was sufficient to pay for the insurance without annual expenditures from the merchandizing income of the mill.

CHARLES T. PLUNKETT asked if the author's statements "depreciation is the falling off in value," and "depreciation begins at once, however small," must be taken in with a series of years in order to make up the depreciation. He was answered in the affirmative.

From the author's statement regarding the making up of the valuations of a plant, "an investigation must be made into the working of the plant, comparing it with other plants in competition with it," Mr. Plunkett wanted to know if the valuations were comparative. The author said he regarded commercial valuations as comparative.

THE AUTHOR. The discussion of the subject has turned upon the matter of depreciation which is quite a difficult problem. It seems that instead of closing the subject with this paper and its discussion an effort should be made on the part of the Society to take up the subject of depreciation and maintenance to determine if possible what may be the best methods to pursue in various industries and so leave the question open for further enlightenment.

MEASUREMENT OF NATURAL GAS

By Thos. R. Weymouth, Published in The Journal for November 1912

ABSTRACT OF PAPER

In the measurement of natural gas there are two distinct requirements to be met. The first relates to the determination of the open flow capacity of gas wells, for which two principal methods are used, namely, the "minute pressure" measurement and the pitot tube. This paper describes these methods, giving the proper formulae to be used with them.

The second requirement is that of the measurement of flow in closed pipes. While large proportional meters are used extensively for this purpose, the high pressures often encountered have a tendency to introduce serious errors, making it necessary to resort to more accurate devices. Of these, the best known are described, namely, the Thomas electric meter, the venturi meter, the pitot tube, and the orifice. The general formulae are given for the last three named, together with their derivations.

DISCUSSION

C. J. Bacon. The principal objection Mr. Weymouth has to the venturi meter is its complicated formula. In view of the amount of preliminary experimental work necessary to establish the coefficient of the pitot tube independently for each condition of velocity, pipe diameter and roughness of interior surface, under which it is to be used, it seems to me that the venturi meter is by far the more generally applicable, since no preliminary work of the above nature is necessary. The coefficient for gas has been determined by various investigators for tubes from 2 in. to 4 and 5 ft. in diameter and has been found to be 98 per cent for the large sizes at the most practicable velocities. By plotting to a wide scale that portion of the formula involving the ratios of areas, pressures and specific heats, the computation of results becomes at least as simple as for the pitot tube. In the usual applications a variation of one per cent in the ratio of specific heat introduces an error of only 0.02 of 1 per cent. In

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my work a ratio of areas of one to nine is generally maintained. The loss of line pressure through venturi gas meters having this ratio of areas has been shown to be 1/9 the differential pressure, therefore not of great importance. The various types of recording instruments on the market make possible continuous records of all data except density. I have had in use for a year or more some combined indicating and recording instruments graduated to show the actual volume of gas passing per minute. One of them is connected to a 54-in. diameter venturi meter located 600 ft. away, and in spite of the distance for transmission of a slight pressure difference it has been found very sensitive and accurate, moreover requiring almost no attention.

C. C. Thomas said that of course it required electric energy to operate the electric gas meter, about 1 or 1½ cents worth per 100,000 cu. ft. of gas measured. It required about 1 kw-hr. per 100,000 cu. ft. of gas. The necessity of increasing the velocity of gas in order to measure it by means of pitot tubes also required energy. In order to produce a readable height of water column (it should not be less than 4 in.) the velocity of gas was increased at the pitot tubes by an amount requiring about 1 per cent more energy to be expended in the pumps than was required with the electric meter installation. This was the case also when the measurement was made by means of orifices, as it was necessary to produce a fall of pressure of about 1 lb. per sq. in. from one side to the other of the orifice. This reduced the suction pressure on the pumps.

Deposit on pitot tubes had a serious effect on accuracy though it was possible to avoid this to some extent by using screws. The pitot tubes were standardized in place, but it was very difficult to check them afterwards. An electric meter could be checked for accuracy at any time simply by throwing in a switch and noting whether or not the system came to a balance. No computation of results or reference to charts was required and no straight length of approach was necessary.

E. A. Hitchcock[1] (written). In 1908 with Mr. Eugene Coste of Toronto I had occasion to standardize with natural gas a set of three pitot tubes, 2, 3 and 4 in. similar to those described by Mr. Weymouth in Par. 27. A total of 34 runs were made under a variety of velocities and pressures, the quantity of gas flowing

[1] Prof. Exper. Engrg., Ohio State Univ., Columbus, Ohio.

being determined by means of a gas holder having a capacity per foot of rise of 5246.5 cu. ft.

In order to reduce to a minimum the effect of temperature on the gas holder all the experimental work was carried on during the night and to obtain parallel flow there was laid a straight run of pipe for 92 ft. leading to the brass pitot tubes.

For gas having a flowing temperature of 40 deg. fahr. with a storage temperature of 50 deg. fahr. and a pressure of 14.7 lb. the constants K were found to be 1511 for the 2-in. tube, 3384 for the 3-in. tube and 5734 for the 4-in. tube where

$$Q.\ (\text{cu. ft. per hr.}) = K \sqrt{\frac{h\,P500}{T}}\ (.668 = \text{sp. gr. gas})$$

The actual diameters of the tubes calibrated were 2.08 in., 3.07 in. and 3.98 in. respectively. It was found, as stated by Mr. Weymouth, that for each tube throughout a wide range of velocity head readings, the coefficient was almost constant.

Taking the constants as given above, solving for Q for any condition, making the proper substitution in Equation [7] and solving for E, I find that E is not constant for the different tubes but decreases with the diameter of the tube:

Actual diameter of tube d, in.	Efficiency E
2.08	0.843
3.07	0.866
3.98	0.874

This is explained in that no correction is made for the area taken up by the dynamic tip in the brass tube. For the above cases this tip had an outside diameter of ½ in. and therefore E will decrease until the actual diameter of the pipe is ½ in. when E would become zero because Q would be zero in that the tube would be plugged with the dynamic tip. For this reason it would seem that d should be taken in actual equivalent diameter.

Mr. Weymouth states that it is not advisable to use the pitot tube for flows giving a differential pressure of less than 2 in. water. Judging by my experience with the type of apparatus he has described, I can readily see why this may be advisable. The reading scale is graduated in 1-10 in. and the average observer will read to the nearest 1-10 in.; therefore with a 2 in. head of water, there might be an error with one reading of 2.2 per cent. Also there seems to be considerable vibration to the water meniscus so that it is difficult to read to less than 1-10 in.

To accept a 2-in. minimum would as a general rule eliminate

the use of the pitot tube for measuring natural gas in a great many cases, for of the many hundreds of readings I have taken during the past 13 years, in the natural gas field on lines from wells to mains and mains to stations the velocities which gave 2 in. or more of water were the exception.

The form of instrument used was a traversing dynamic tube made of 1.4-in. brass pipe, a stationary static tube of the same size and material and the form of manometer brought out by Prof. S. W. Robinson. With this form of apparatus and using alcohol in the manometer there is no difficulty in reading to 1-100 in. which, with a velocity head of only ½ in. and an error in reading of 1-100 in., would mean an error in the quantity of gas flowing of only 1.4 per cent and this probable error is reduced by taking many independent readings.

The greatest advantage of the pitot tube in the measurement of natural gas is its great simplicity and ease of application. Several determinations can be made during the same day on different lines in the same field in that it should not take more than one hour to connect the instrument to the line after the gas pressure has been reduced to 20 lb. or less.

THE AUTHOR. In referring to the preliminary work necessary to establish the coefficient of the pitot tube Mr. Bacon doubtless had in mind the form of tube intended to be used within an ordinary pipe. In this form the pitot tube is more of a portable instrument than one adapted for permanent installation, and should not be compared to the venturi meter. For such comparison the form of tube described in Par. 22 must be chosen, inasmuch as its field of usefulness is the same as that of the venturi meter. The total amount of preliminary work necessary with this type of tube is merely its calibration against a standard tube or other accurate measuring device and involves from one to four hours' time, which seems to the author to be about as little as one could expect to be spent upon any instrument of the importance of those considered. Much labor and painstaking care were applied to the derivation of the coefficients of the standard tubes mentioned in Par. 23, but these coefficients having once been determined, it is a simple process to ascertain from them the coefficients of the other tubes calibrated against them. The standard tubes are preserved in a testing station used solely for the calibration of other tubes and are in service only during the progress of such calibration work.

The computation of the quantity of gas passing through pitot tubes in commercial use is extremely simple. From a book of tabulated values of $\sqrt{h\,(p+14.4)}$ corresponding to all values of h from 0 to 28 in. of water, by tenths, and of p from 0 to 500 lb. gage, by pounds, the value of $\sqrt{h\,(p+14.4)}$ corresponding to observed readings of h and p is read off and written on a form every 15 minutes. At the end of the day these "extensions" or values of $\sqrt{hP}$ are added and the sum multiplied by the quarter-hour coefficient of the tube used, giving the total quantity of gas passed. The method of computation of venturi meter observations as outlined by Mr. Bacon does simplify the use of the formula of Par. 12, but can hardly be said to be as simple as the pitot tube computation, as it would require first, the computation of $\frac{P_2}{P_1}$ from the observations of P_1 and $P_1 - P_2$. Then the corresponding value of the radical must be obtained from the chart. This value must then be multiplied by the value of P_1 and also by a constant, depending upon the particular venturi instrument used and the remaining factors in the formula. This computation could all be reduced to much simpler form, however, if tables were computed giving the values of $\frac{Q}{A_2}$ for all possible combinations of P_1 and P_2. Such tables would then be applicable to all venturi meters with the same ratio of entrance area to throat area.

The cost of measuring gas by pitot tube as influenced by the drop in pressure can be made small by properly designing the station. In the case assumed by Professor Thomas, the pressure drop of 28 in. or about 1 lb. would be equivalent to 1.2 hp-hr. per 100,000 cu. ft. per hr., assuming the gas to be pumped from 80 to 350 lb. gage pressure. By using a 6-in. tube instead of a 5-in., the drop in pressure would be reduced about 50 per cent, measuring the same quantity of gas, and the cost would thus be cut in half.

It is true that if pitot tubes should be filled with deposit their coefficients, which vary as d^2, would be seriously affected. As a matter of fact, however, such deposits do not form, due to the high velocity of the gas in the polished tube. Sometimes the tips will become clogged with dirt, but this instantly becomes apparent on the gages and the tips can then be "blown out" or removed from the tubes and cleaned.

All pitot tube stations should be installed with provision for inserting a portable standard tube for calibrating the permanent tubes. It is then a simple matter to standardize all the tubes in a station as frequently as is necessary.

The coefficients of the tubes referred to in Par. 28 were determined in the same manner as those described by Professor Hitchcock and the author is unable to understand the variation in the values of E as shown by him. Even though the tip were assumed to be so large as to fill the pipe it would not mean that E would fall to zero, for while Q would then be zero, h would also be zero, and E could remain constant.

The limits mentioned in Par. 33 apply only to installations of the type described, and are a result of the simple form of U-gage scale usually used with such permanent stations. When a properly designed scale is used for the accurate reading of small differential pressures, the range of the pitot tube is increased to give accurate measurements over extremely wide limits, for the fundamental principle of the tube itself holds good irrespective of the velocity, and the question resolves itself into one of the accurate measurement of small differences in pressure. This is especially true in portable tubes or tips. The author makes use of such a form in field work, especially in the measurement of the capacity of wells feeding into main lines, and obtains very accurate results with small differentials by using an inclined U-gage.

Where trouble is experienced from vibration of the water meniscus, it can be overcome by inserting in each of the pressure lines a diaphragm with a hole in it about 1/32 in. in diameter. If the installation is permanent the same object may be attained by inserting in each of the pressure lines a joint of 6-in. pipe, capped on both ends, for acting as a reservoir or cushion to dampen the vibrations and give a true average of the pressures.

MEASUREMENT OF AIR IN FAN WORK

By Charles H. Treat, Published in The Journal for September 1912

ABSTRACT OF PAPER

The paper discusses the use of the pitot tube for fan testing with particular emphasis on the correct kind of tube to be used. It describes a simple and accurate method of calibration of impact and static orifices, and the instruments to be used in fan testing, as well as the general method and arrangement of the tests. It shows further the derivation of the formula for friction in test pipe, and the method of correcting test results to standard weight air. The paper further contains proofs that the volume discharged from a fan is the same at all densities, other conditions being the same, and indicates the formulae and calculations used in the test, such as the formula for the determination of air horsepower on the discharge and suction side, efficiency of a fan and its speed. Finally, the question of the average velocity of flow in a pipe is discussed.

DISCUSSION

W. H. Carrier stated that the same kind of pitot tube as that used by Mr. Treat had been used for a long time at the works of the Buffalo Forge Company, however, instead of using two tubes side by side, connecting to the static member and to the total pressure member, one tube is placed inside of the other, so that the pitot tube can be more easily inserted in the pipe. In this construction there is only one pipe to be handled, and it requires only about one-half as long to construct as Mr. Treat's.

There is one point worthy of particular attention as the feature probably responsible for a very large amount of inaccuracies in fan tests and misleading statements as to efficiencies, such as claims of efficiencies of 83 per cent or even as high as 90 per cent, which cannot be attained in ordinary fans for low-pressure work. The actual efficiency of those of the very best design working under the best conditions is 70 to 75 per cent, while fans of the multivane types of ordinary commercial design have efficiencies

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varying from 45 to 60 per cent only. The reason why unusual efficiencies are shown in some tests is in all probability because of a slight leak in the static member, which usually happens unless precautions are taken. This leak reduces the static pressure and a further reduction may be produced by some of the minute openings being clogged by dirt. Even a small reduction, say 5 per cent, will produce an apparent error in the reading of the velocity pressure of about 15 per cent, which will result in the amount of air calculated as delivered being 7 or 8 per cent larger than is actually the case. The error due to these causes may often be as large as 20 to 30 per cent. The proper method is to test the connections to both the static and total members as to tightness by blowing into the connecting tube, depressing the water column, and then holding it, with the thumb over the opening, to see if any drop occurs in the water column.

Sanford A. Moss. Experience with velocities of the order of magnitude of those used by Mr. Treat as well as very much higher velocities has shown that Mr. Treat is correct when he states that for any ordinary change in an impact tube no inaccuracy results but that a static orifice which reads correctly is not easily obtained. I have had most successful results in measurement of static pressure by means of a hole in the pipe wall, succeeded by some length of straight pipe and preceded by a considerable length of straight pipe. With the static pressure obtained in such a way the pitot tube becomes merely an impact tube.

Some years ago I used an arrangement such as is shown in Mr. Treat's Fig. 3 with a jet discharging into the atmosphere. Mr. Treat, however, seems to use a jet discharging from a long straight pipe of constant diameter. In such a case the velocities at the point of discharge are variable and gradually decrease from the maximum value at the center to a small value close to the edge. As is well known, the curve giving these velocities for various diameters is an ellipse. I used an orifice consisting of a gradually rounded approach succeeded by a parallel portion about one diameter in length and preceded by a long straight pipe with a diameter about three times that of the parallel portion at the discharge of the orifice. It can be shown that such an orifice gives a jet with practically uniform velocity and that the pressure in the jet must be atmospheric.

I inserted a pitot tube similar to that used by Mr. Treat in

such a high velocity jet and found that for high velocities static pressure was very slightly less than atmospheric. For a velocity of about 400 ft. per sec. the static pressure was 0.6 in. of water below atmosphere. For velocity up to about 80 ft. per sec. the static pressure was practically atmospheric. Other forms of pitot tube in such a jet showed static readings with much greater errors.

Mr. Treat's suggestion regarding an inclined gasolene tube for pressures of less than 1 in. of water is very interesting. I would like to inquire how he secures an exact value of the zero angle, how he secures the density of the gasolene and how he avoids change of density by evaporation of the more volatile part of the gasolene from time to time.

The variation of pressure with square of velocity and power with cube of velocity for a fan discharging against constant resistances mentioned by Mr. Treat was considered theoretically by Professor Rateau many years ago and is undoubtedly a very exact relation so long as the pressures are so low that the change of density is not appreciable.

All of Mr. Treat's methods seem very carefully and accurately laid out and it is pleasant to know that the measurement of quantity in his fan blower work is being carried out with precision.

J. H. Browne said he would like to see some method developed by which the pitot tube could be used when the fan is used to produce either forced draft under a boiler or induced draft over a boiler. This would show the exact conditions of operation better than the ordinary water tube or inclined gage because in the latter case the thickness of the fire affects the results.

C. G. de Laval (written). On using a pitot tube for measurement of air one must not overlook the question of moisture in the air as this affects the air density; also, when water is present there will be a wide variation in the velocity, so that to be fully accurate relative humidity should be taken into account. In the usual cases the velocity is not constant in the cross-section and particular care has to be exercised to read the pitot tube carefully; wrong records may be due to fluctuations, and coefficients of corrections have to be used in order to get the correct measurement. The paper aims to show a tube that would give accurate results in a simple way; the best and most reliable is one that will combine the impact and static in one, and in such a way that the

dynamic and aspiration effects neutralize each other so that the real pressure is obtained.

For measuring air velocity by the formula $v = \sqrt{2gh}$, the density of air and its velocity head, temperature, atmospheric pressure and moisture must be taken into account.

The density

$$D = \frac{0.0807\ (p - 0.379\ hv)}{(1 + zt)29.921}$$

where

0.0807 = weight of 1 cu. ft. dry air at 32 deg. fahr. and atmosphereric pressure of 29.921 in.

p = atmospheric pressure

h = relative humidity

v = vapor pressure

$1 + zt$ = ratio of volumes of dry air at 32 deg. fahr. and at $(32 + t)$ deg. fahr.

t = temperature of dry air above 32 deg. fahr.

0.379 = per cent of vapor in 1 lb. saturated air at 32 deg.

It is believed that a single tube at center will correctly register the velocity with a correction of 4 to 5 per cent for the average over the entire pipe or outlet and that it will be necessary to correct further for moisture in the air; it will be also found that the velocity of the air materially affects the correctness of readings by pitot tubes. For low velocities, say below 5000 ft. per min., a special form of gages will have to be used in order to be reliable and to register accurately the velocity heads, while for higher velocities the instruments of the pitot tubes are fairly reliable as to readings.

The electric meter is probably the most accurate, it measures the energy necessary to cause change in temperature, and this is proportional to the weight of air flowing.

$$Q = \frac{E}{t \times s}$$

E = energy to raise temperature

Q = weight of air through t deg.

s = specific heat of unit of weight at constant pressure.

The electric meter is independent of variation in velocity of the air at the different parts of pipe. Measurements used are all electric and can be read to close observation and are not affected as in the pitot tube and venturi meter by eddies and pulsations. It

is to be noted that neither pitot nor venturi meters will or can lend themselves to continuous graphical results due to the small power available for recording, while the electric meter of Professor Thomas can give a continuous reading through an ordinary watt-meter, and which is still better, the readings can all be obtained without any calculation, as it necessitates only the electrical energy transformed into standard cubic feet, and its accuracy depends only on its ability of measuring electrical energy.

In closing, Prof. C. C. Thomas stated, in reply to a question from Mr. Moss, that in regard to the use of light fluids such as gasolene for maintaining the difference between the static and velocity pressures, there was some difficulty at times due to the varying vapor pressures in the gages. Almost all such gages are closed at one end, and there is a different pressure above the fluid for each temperature, so that in summer it is difficult to get the same results as in winter.

The range of the pitot tube stations is determined by the smallest and the greatest heights of water columns which it is found practicable to read accurately, and to obtain. About 4 in. is the lower limit and 28 in. the higher. This gives the tube a measuring range of the square root of 7 or about as 1 is to 2½.

The author's closure is to be published later.—EDITOR.

AIR IN SURFACE CONDENSATION

By Geo. A. Orrok, Published in The Journal for November 1912

ABSTRACT OF PAPER

This paper is an addition to the author's paper on the Transmission of Heat in Surface Condensation and gives the results of his investigations on the amount of air present in feedwater and the presence and effect of air in surface condensers, and describes an apparatus for measuring the air leakage.

DISCUSSION

H. A. Everett.[1] Air has such a serious retarding effect upon condensation that any work which permits of a closer analysis of its effect is of prime importance in condenser design, and we are greatly indebted to Mr. Orrok for his work in this direction.

In 1908 D. B. Morison[2] as the result of experimental observation, said that "when the entire feedwater passes through an air pump the air in the pump discharge amounts to from 1½ to 2½ per cent by volume of the water, and that fresh water carried in tanks for use as auxiliary feed contains from 2 to 3½ per cent of air by volume." These are in accordance with the values given by Mr. Orrok and are interesting as confirmatory data.

With reference to air entering by leakage there have been to date no quantitative experiments published, and those given by Mr. Orrok are of tremendous value. From them it appears doubtful if, in any case of normal leakage, the air present would be sufficient to affect appreciably the temperature of the steam at *entrance* to the condenser, though of course during the passage *through* the condenser the air richness is in ever increasing proportion as the steam is condensed out, and its effect upon condensation becomes of vital importance. The deterrent action of

[1] Assist. Prof. Naval Architecture, Mass. Inst. Tech., Boston.

[2] Trans. Inst. Naval Architects, vol. 50, p. 150

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air on heat transference is apparently a dual one, (*a*), the insulating effect upon the tubes and (*b*), the reduction in the temperature of the steam by the reduction of the partial pressure due to the steam as the steam is condensed out and the air richness increases.

From the experiments by J. E. Smith[1] Mr. Orrok concluded in 1910 that the heat transference is proportional to the ratio of the partial pressure of the steam to the total pressure raised to the fifth power $\left(\frac{P_s}{P_t}\right)^5$ and now suggests the second power as being desirable. It should be borne in mind that the experiments of Mr. Smith were made in a condenser with no air pump, and therefore the flow of steam by the tubes was very slight. This would have the effect of permitting the zone of air around each tube to be much larger than in actual condensers where the velocity of the steam by the tubes is great, and therefore its effect would be correspondingly greater, for air is a good thermal insulator.

While this would account for the rejection of the fifth power, is Mr. Orrok warranted in suggesting two as the exponent for the ratio $\frac{P_s}{P_t}$? As from his plot of Fig. 6 the exponent is evidently considerably nearer unity than two and it is much to be desired that a description be given of the manner in which the data for the curves of Fig. 6 were taken, as knowledge of this would be of great assistance in determining the reliance to be placed upon a factor of such prime importance in his equation.

Past experience in the determination of temperatures inside of condensers during operation has been most unsatisfactory, and data of this sort will be very welcome to those engaged in condenser design. In view of the apparent unreliableness of the factor $\frac{P_s}{P_t}$ for determining the effect of air, would it not be desirable to drop the term from the original equation and to obtain the reduction in heat transference due to air leakage in another way? If temperatures might be predicted at different intervals down the tubing, it would be comparatively easy to estimate the actual heat value of surfaces located at these points from which a total or mean value could readily be derived.

[1] Victorian Institution of Engineers, December, 1905

A. G. Christie. Mr. Orrok is to be congratulated for his initiative in undertaking such a complete series of tests the results of which, as embodied in his paper, give data and information of great value to designing and operating engineers of power plants using surface condensers. His discussion not only throws new light on some vaguely understood conditions, but also offers a solution to many questions in plant operation which have puzzled engineers. The simplicity and reliability of the methods and apparatus employed by Mr. Orrok deserve commendation. The tests have proved the effectiveness and usefulness of open heaters as air removers from boiler feedwater. This decrease in air carried to boilers not only improves the vacuum but also reduces boiler corrosion.

It is stated that most of the air comes into the condensing system through leakage in the cast-iron shells, gaskets and expansion joints. A number of years ago it was noted in a barometric condenser installation that air leakage was apparently taking place under high vacuum through the cast-iron pipes themselves as the vacuum could be improved by painting the pipes with asphaltum. The piping was well made and apparently free from blow-holes. The theory was advanced that cast iron was more or less porous to air when subjected to high vacuum. In order to test this theory some cast-iron exhaust pipes of good quality were secured from a leading condenser manufacturer and tests conducted under the writer's direction at the University of Wisconsin. It was first attempted to measure the air leakage by a method similar to Mr. Orrok's, but this was not found sensitive enough under the circumstances. Comparative results were obtained by producing a high vacuum in the piping by means of a Hubbard pump, closing off all connections and noting the rate of decrease of vacuum. Knowing the volume of the pipes, the rate of air leakage could be computed.

It was also decided to test the effectiveness of several commercial paints or coatings for vacuum work and to note their performance under heat. A study of the results of these tests led to the following conclusions: The actual leakage of air into the pipes was very small and would not amount to any significant quantity as compared with the other volumes of air that entered through other sources. It is quite probable that practically all this leakage was through the valves, pipe connections and gaskets under the end heads. The rate of leakage was practically

constant whether the pipes were bare or painted. It might therefore be said that good cast-iron pipe with a coat of suitable paint is proof against any considerable leakage of air.

Considerable trouble was experienced in preventing air leaks through the gaskets under the end heads, especially after the pipe had been heated up. Hence the bolts and gaskets at the joints should receive particular attention when air leaks are suspected. The use of cloth inserted gaskets should be avoided.

The tests were not conclusive with regard to the effectiveness of the different paints in reducing vacuum losses. Paints with asphaltum base were very effective in preventing leaks at low temperatures, but softened and tended to drip at temperatures from 210 deg. to 225 deg. fahr., which would occur should the vacuum fail. One paint, said to be a linseed oil preparation with a peroxide of iron base, formed a close impervious film on the piping and showed no deterioration from the temperature changes within the range of the tests.

It would therefore seem that if the cast-iron portions of the condensing equipment were covered with a suitable paint, the only remaining sources of trouble from air leakage would be the bolts and gaskets at the joints.

Referring to Par. 28, the writer has frequently been puzzled to account for inconsistencies in vacuum temperatures and will welcome any new information on this subject. In one test several calibrated thermometers were tried in a well in a certain part of a jet condenser apparently well out of the path of the steam, yet each showed a higher temperature than that corresponding to the vacuum shown by an adjacent mercury column. On another test the exact opposite occurred as the temperatures observed were much too low to be accounted for by partial pressures of the air present.

In regard to the drop in vacuum through condensers, it is of interest to note European practice in condenser construction. Some British manufacturers maintain that for high efficiency of the condenser, the steam path must be so designed as to obtain high velocity through all the tubes with small loss of head. This requires a straight path through the condenser with no baffle plates and also requires a condenser with decreasing cross-section from the steam inlet. Such construction avoids dead corners for the collection of air, and at the same time, the condensed steam is swept off the tubes as fast as it forms by the high velocity.

Many continental manufacturers have adopted the practice of leaving open channels through the nests of tubes to provide ready access of the steam to all cooling surfaces. As a rule baffle plates are also employed to direct the condensation to the side of the shell instead of allowing it to drip over the tubes below.

The theory advanced by several writers that seems to account in the best manner for the fall in vacuum with increased quantities of air is as follows: As steam condenses on the tube surfaces, the air is left behind and the medium surrounding the tube then contains proportionately much greater quantities of air than the steam entering the condenser. The pressure of this air lowers the partial pressure of the steam and consequently its temperature. Hence there is a less temperature difference between the tubes and the steam and therefore the rate of condensation is lowered. This theory emphasizes the necessity of providing in the design for a rapid sweeping away of the air to the air pump as the steam condenses. The high velocities maintained in some British condensers assist materially in securing this result.

William Weir.[1] As the writer's experience is chiefly associated with marine practice it differs from Mr. Orrok's on many points, but the differences may be of interest particularly as the limitations of weight and space on board ship entail the utmost care in the design of a condensing installation.

The question of air to be handled by the air pump naturally divides itself into two considerations, the amount of air entering the system through the medium of the feedwater and the amount of air entering the system as direct leakage. Apart from thermal considerations, the Weir direct-contact feedheater was introduced to prevent boiler corrosion due principally to the air and other gases contained in the feedwater. This type of heater is situated on the suction side of the feed pumps, subjecting the feedwater to a reduction of pressure and an increase of temperature, which results in the water boiling and giving off the air and gas practically in their entirety. In the absence of such apparatus the feedwater will enter the boiler containing air in proportion to the feed temperature at the feed pump suction.

As regards the amount of air in feedwater at different temperatures, the writer cannot agree with J. A. Smith's curve of emissivity of gases as in his experiments emissivity was almost

[1] G. & J. Weir, Ltd., Cathcart, Glasgow, N. B.

entirely controlled by convection due to the stagnant condition of the experimental medium. Feedwater in any feed system is practically never still, and the actual curve of emissivity is of a totally different nature to that shown by Mr. Smith, and broadly speaking shows greater emissivity at the commencement of the heating range than at the later stages.

In turbine installations other controlling factors generally prevent the adoption of direct-contact feedwater heaters, and accordingly the feed heating is generally done on the pressure side, which does not affect to any great extent the amount of air entering with the feedwater. In such installations a large proportion of the total air enters with the feedwater. It is astonishing, however, to note that Mr. Orrok considers 15 to 20 cu. ft. of free air per minute a reasonable total air leakage on say a 12,000 kw. installation. This seems abnormally high, and quite incompatible with good workmanship, or if associated with turbine packing glands, with good design.

The first essential in any plant designed for high vacuum is to take every possible measure to keep the air out, and the actual air leakage into such a system may be reduced in every case to a comparatively trivial amount. In marine work the condenser shells are of steel plate, and in every case the entire low-pressure system is carefully water tested after erection and before starting up, and even in land installations wherein the condensers are sometimes of cast iron, it is not difficult to maintain practically complete air-tightness particularly in a land installation where the eduction pipe inlet to the condenser is water sealed, and wherein the only other pipe connections are on a simple line of air pump suction pipes. It will be obvious that in a marine installation the difficulty is much greater owing to the extensive and complicated pipe system under the vacuum.

Mr. Orrok's experience differs also as regards air leakage at light loads, as light loads are always associated with less air leakage. It may be of interest to give an actual example of this phenomenon. Take a torpedo boat destroyer of 20,000 s.h.p. On this vessel there are two main condensers of 6000 sq. ft. each, i.e. the total cooling surface is 12,000 sq. ft; there are two main air pumps of the Weir dual type each comprising two barrels 22 in. in diameter by 15 in. stroke. At full power with a sea temperature of 55 deg. the vacuum is 28.2 in. with both air pumps running at 50 double strokes per minute. At cruising power say 2000 s.h.p.,

with one air pump running at 30 double strokes on both condensers the vacuum is 28.9 in., in other words, the air to be handled by the air pump in a tight system is largely controlled by the actual amount of feedwater, and correspondingly the air brought over with it.

In connection with this example it may be of interest for American central station engineers to consider the relative proportions as regards cooling surface of these "uniflux" condensers as compared with the land practice obtaining in their country.

With regard to Mr. Orrok's remarks on the loss of pressure between the exhaust pipe and condenser base, it does not seem to be a matter of shallow condensers as compared with deep condensers, but rather the adherence to the correct principles of design as regards permissible steam velocities, contour of shell, and pitch of tubes, which governs the question.

With reference to the effect of air on the actual heat transmission in surface condensers, it is apparent that this effect is different on practically every row of tubes in a surface condenser, and accordingly such experiments as J. A. Smith's are of little practical value as the element of steam flow or velocity was entirely absent.

Mr. Orrok's paper tends to confirm the writer's experience with dry air pumps of the type he has dealt with, and it has always been a matter of wonder that such types should have been adopted on any scale. All such pumps are greatly handicapped as compared with the ordinary three-valve air pump fitted with cold injection supply, and in this connection it may be of interest to refer to a paper read recently by the writer before the Institution of Engineers and Shipbuilders in Scotland, wherein are given a number of particulars concerning marine practice in surface condensing installations.

J. J. Brown. In connection with the author's figures as to the amount of air entering through the prime mover, the following data, showing the amount of air entering through turbine seals, may be of interest. They were obtained by the Wheeler Condenser & Engineering Company with their portable testing gasometer, similar in design to Mr. Orrok's, and may serve to emphasize the importance of maintaining proper pressure on the steam seals.

In the test in question, which was made on a jet condenser

serving a 2000-kw. turbine, at no load and with no steam on the turbine seals a total of 86 cu. ft. of free air per minute entered the condenser, a corrected vacuum of 26.6 in. being maintained under this condition. With a normal amount of steam on the seals, and a mercury manometer registering a slight pressure, 64 cu. ft. per min. entered the condenser at no load, and the vacuum was raised to 28.5 in. On a similar unit of like size, approximately the same figures were obtained, as follows: with a load of 1650 kw. on the turbine, and no steam on the seals, 91 cu. ft. of free air per minute entered the condenser, the vacuum dropping to 25.9 in., corrected. With normal steam pressure on the seals, the amount of air was reduced to 56 cu. ft. and the vacuum increased to 28.1 in. A further increase of pressure on the seals had no appreciable effect.

It is interesting to note that the abnormal quantity of air discovered by these tests enabled the detection of leaks. Upon remedying them, the condensing plant operated well above the guarantee.

Mr. Orrok's chemical determination of the amount of air in feedwater suggests some rather unusual figures recently obtained while testing a unit. As is known, the normal quantity of oxygen in free air amounts to about 20.7 per cent. Analysis of the air extracted from a condenser revealed the fact that this amount of oxygen had been increased to an even 25 per cent, the relative quantities of CO and CO_2 remaining the same. These figures correspond to the 20 to 30 per cent of oxygen obtained by J. A. Smith,[1] in analyzing the non-condensible vapors from a condenser.

In Fig. 3 are given curves showing the relation between load and the drop in vacuum through the condenser. Were these tests made at approximately the same vacuum, and did this vacuum remain practically constant throughout the range of load represented by each of the curves? It is well known that decreasing the pressure increases the volume; in accordance with the laws for flow of gases through orifices, by which the loss of pressure is stated as varying as the square of the velocity and inversely as the density, a loss of pressure twice as great would be expected if the velocity were doubled by doubling the volume, with the weight of steam remaining constant.

In connection with this subject of drop in pressure through

[1] London Engineering, Oct. 7, 1904

condensers, experience has shown that a proper arrangement of tube surface will reduce this loss to a fraction of an inch. The most important consideration is that the incoming steam meet the maximum initial exposure of tube surface, and rectangular shells have been developed with this point in view. This is probably the nearest commercial approach to the wide shallow condensers which Mr. Orrok states should give the best results and with them during the winter season vacuums of 29.3 to 29.5 at 30 in. barometer have been maintained. The drop in pressure at the enormous volumes reached with these vacuums would be considerably larger than at 28 in., so it is evident that the loss is not excessive.

Another point to be remembered is that the volume of air increases tremendously at high vacuums. The addition of air to the total volume hence operates to cause a greater drop in pressure. While the presence of air in a condenser is detrimental under any condition, its effect is most clearly demonstrated at these high vacuums.

From the standpoint of the condenser manufacturer, it is of great value to have such a paper as Mr. Orrok's brought to the attention of engineers, and it is to be hoped that the time will come when every power station will be equipped with a gasometer or a similar device for testing for air leaks. As it is now, the condenser manufacturer must design his air pumps to handle not only the air which he knows by experience will enter with the steam or by infiltration; in addition, he must assume the responsibility for turbine seals, for careless pipe joints, and for slipshod maintenance. That is, he must proportion his air pumps to handle far more air than should be necessary, and the net result is a considerable over-all loss. It is no exaggeration to say probably over 75 per cent of the vacuum troubles in condensers today may be traced directly to an abnormal air leakage. It is to be hoped that further investigations similar to Mr. Orrok's will be made, in an attempt to determine the air displacement necessary, say per 1000 lb. of steam under standard conditions. The company with which the writer is connected has been working on this subject for the past two years, but if such a figure could be obtained by independent investigators it would define sharply the responsibility of the condenser manufacturer, and it would result in more careful attendance of plant and in higher efficiency, for, as Mr. Orrok points out,

"the work necessary to maintain tight condensers more than pays for itself."

G. J. Foran. The entire membership of the Society is indebted to Mr. Orrok for the data presented upon the amount and variation of air leaks found in large operating units and the effect upon the results obtained.

As I understand it, Mr. Orrok presented the paper without comment on much of the data, with the idea of creating an interest and starting discussion upon the various lines. The brevity of the presentation and the absence of any discussion or demonstration of the data has already caused some misunderstanding and certain discussions which Mr. Orrok would probably not endorse.

The entire field of the effect of air upon surface or jet condensation has been the subject of special study by me for many years, but I shall confine myself only to features of unusual interest or the discussion of such data as might lead to erroneous deductions.

Referring first to the percentage of air by volume at various temperatures, as given in Par. 6, the variation in percentage corresponds quite closely to my own observations and study, and in ratio of variation, although not in exact quantity, to Winkler's tables as presented in Castell-Evan's Physico-Chemical Tables, edition 1911. Two tables are given showing the absorption of air by water at different temperatures; the first table assuming that the pressure of the *air* outside of the liquid is constant at 760 millimeters, the second table assuming that the total pressure outside of the liquid remains constant at 760 millimeters, the pressure due to the air being the difference between the total pressure (760 millimeters) and the pressure of the aqueous vapor due to the temperature. The tables were calculated from the absorption power of water for oxygen and nitrogen in the necessary ratio for the formation of air; the volume of air so stated is always stated in *dry* air, not saturated, a fact not definitely stated and usually overlooked.

Heretofore it has been customary in condenser work to base all calculations for the air contained in the water upon the ratio of total pressures and temperatures. It is apparent that this should be modified upon the basis of the second table referred to, and that the quantity of air present, outside of temperature considerations depends solely upon that proportion of the outside pressure due to the *air* alone.

It is well known that if a given space is saturated with aqueous vapor at a given temperature, the corresponding pressure and weight of aqueous vapor is definitely known and may be found in saturated steam tables, and this pressure and weight is absolutely independent of the presence of air or other gases. These other gases will influence the total pressure in the space, and they themselves will have a pressure and weight proportional to their portion of the total pressure; but the pressure and weight of the aqueous vapor remains the same as if there were no other gases present.

In Fig. 7 are curves, *A* and *B*, plotted from Winkler's tables with the percentage of air laid out as ordinates and the temperatures as abscissae. A third curve, *C*, shows the difference between the two and curve *D* is plotted with inches of air pressure as abscissae. Comparing the percentage of air, as given by Mr. Orrok, in water at 187 deg. and 52 deg., the ratios agree within 4 per cent with those shown on the curve for Winkler's second table, (air-β_1). The percentage present in the hot-well water, based upon an assumed pressure in the steam space above the hot well taken by comparisons in Table 1 also corresponds very closely, that is, assuming a vacuum corresponding to a temperature 30 deg. above the hot-well temperature.

It may be claimed that the water tested was not under the absolute conditions required for the application of Winkler's tables. Strictly speaking this is true, but I believe the deviations do not seriously affect the consideration, and under any interpretation they do not approximate the ratio shown in Winkler's first table. There is not space here to discuss this question in detail, but if careful tests were made in practice, with the idea of obtaining the method of variation, I feel certain they would be found to conform so accurately that the curve mentioned for the variation in percentage of air present, although naturally not for the actual quantity, which varies widely, could be followed with reasonable safety.

It should be remembered that the absorption of air by water is a very slow process and does not compare with the speed of saturation of a space containing water at high temperature. We are apt to confuse these two as we are more used to considering the latter case.

Referring to Par. 7, Mr. Orrok does not give his method for determining the figure of $^1/_7$ for the air volume compared with

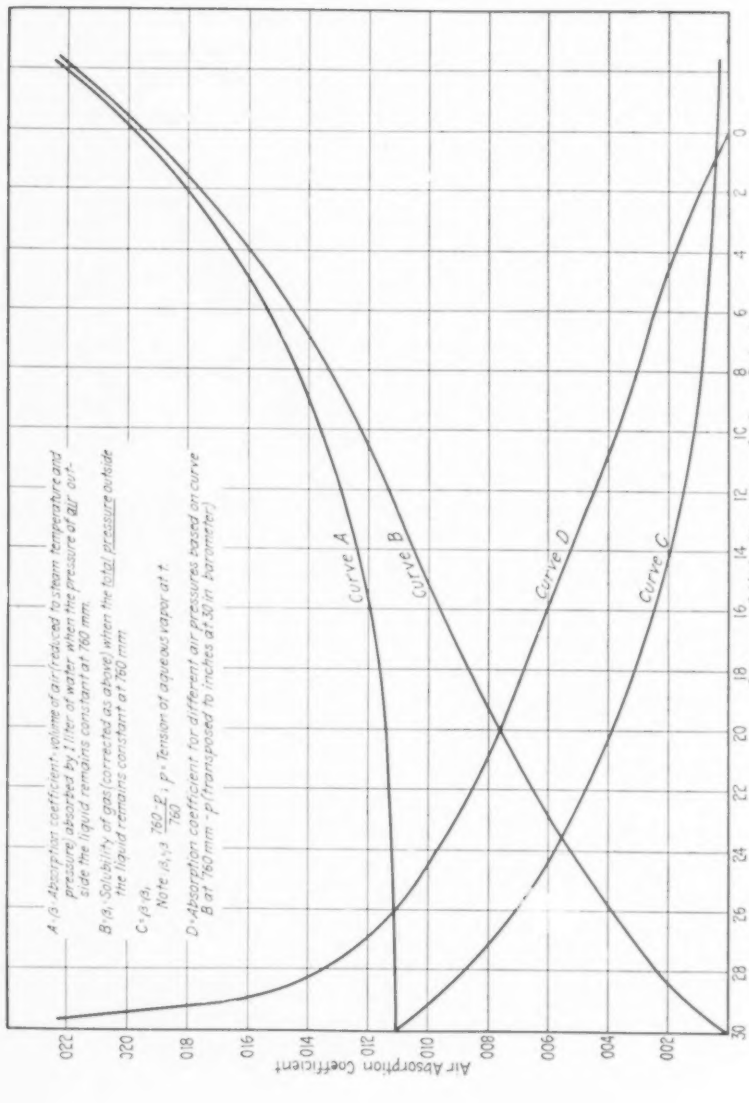
A = β Absorption coefficient, volume of air reduced to steam temperature and pressure, absorbed by 1 liter of water when the pressure of air outside the liquid remains constant at 760 mm
B = β, Solubility of gas (corrected as above) when the total pressure outside the liquid remains constant at 760 mm
C = β β,
Note β β = 760 − p / 760 , p = Tension of aqueous vapor at t°
D = Absorption coefficient for different air pressures based on curve B at 760 mm = p (transposed to inches at 30 in. barometer)
Curve A
Curve B
Curve D
Curve C
Air Absorption Coefficient
.022
.020
.018
.016
.014
.012
.010
.008
.006
.004
.002
30 28 26 24 22 20 18 16 14 12 10 8 6 4 2 0
Pressure of Air in Atmosphere for Curve D, Inches
212 Temp deg fahr 132 172 152 132 112 92 72 52
100 Temp deg cent 88.8 77.7 66.6 55.5 44.4 33.2 22.2 11.1
Temperature of Water (and Air) for Curves A, B and C

FIG. 7 CURVE SHOWING SOLUBILITY OF GASES IN WATER AT ATMOSPHERIC PRESSURE, CALCULATED FROM NITROGEN AND OXYGEN (WINKLER)[1]

[1] See table in Castell-Evans Physico-Chemical Tables, vol. 2, p. 993, ed. 1911.

that of the condensed steam. This is evidently an error, however, as the writer makes this figure 25 per cent, or one-fourth the volume of the condensed steam upon the usual basis of comparison of total pressures, or 10.2 per cent based upon the air pressure alone. With 2 in. absolute in the condenser, however, I believe the temperature of saturation would not be 81 deg. in the condenser, but more nearly 99 deg., or approximately within 2 deg. of the temperature corresponding to the vacuum; which would increase the volumetric percentages given above more than seven times. Several have misunderstood Par. 7 and assumed that the temperature of saturation in the condenser always corresponds to the hot-well temperature. They never do, except by chance, their determination being due to different causes. This is shown by Table 1, the temperature in the steam space averaging more than 30 deg. above the hot-well temperature, and even the cooled vapors at the air suction being at a higher temperature than at the hot-well.

Regarding the gasometer, it is assumed that the water temperature and the air in the bell both have the external air temperature. These observations are of great interest in determining the air leakage in different plants, and of course this more or less determines the vacuum carried. However, an attempt to make too close a study of the air conditions in the condenser or in the vacuum pump, or the vacuum pump efficiency, from the observations as recorded in Table 1 should not be made, for the reason, as stated by Mr. Orrok, that in some cases the temperatures recorded are temperatures by convection from some other point of the apparatus, rather than of the air itself.

It is unfortunate that nothing definite is given as to the condition of the vacuum pumps and the vacuum they were able to maintain upon a closed suction. It is assumed that the various pumps are fitted with by-pass valves.

In Par. 27 the statement is made that the volumetric efficiency of the vacuum pump is very poor indeed. This statement should be qualified. The volumetric efficiency of such pumps is, on the contrary, very high, but in the cases observed apparently the vacuum pumps were set to operate at a speed that would give a displacement much greater than the required capacity. In that case it is evident that the unneccesary volumetric displacement would be filled with steam from the condenser, and therefore, when the comparison is made between the air in the bell and

[See table in Castell-Evans Physico-Chemical Tables, vol. 2, p. 903, ed. 1911.

the pump displacement, the volumetric efficiency of the pump appears poor.

It is evident that considerable steam was carried into these vacuum pumps in the manner stated. Take for example the results given on the ninth line: Here the steam cylinder is shown as developing 23.32 i.h.p., the vacuum cylinder 10.58 h.p., but the equivalent of heat taken away by the jacket water amounts to 25.8 h.p. This shows a large condensation of steam with the consequent surrender of its latent heat, and it is much greater than would correspond to the amount of saturation corresponding to the temperature and pressure carried at the suction.

The condition of the air entering the vacuum pump is of great importance. If dry air were compressed adiabatically from 2 in. to 30 in. absolute, the air having an initial temperature of 60

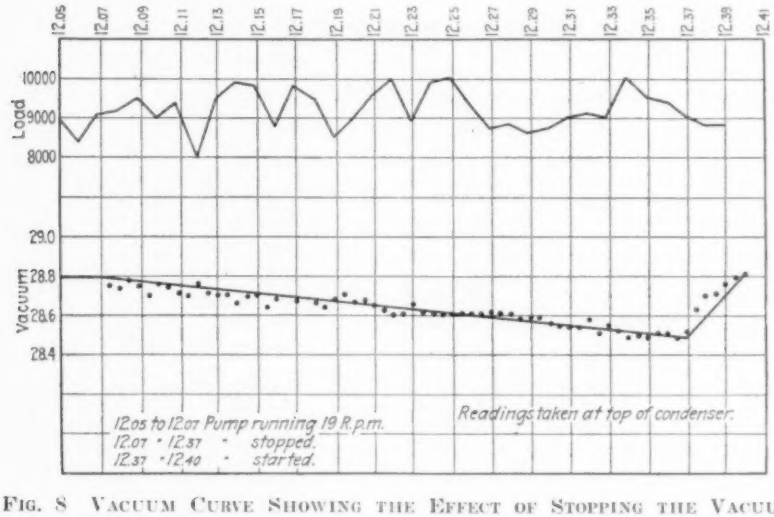

FIG. 8 VACUUM CURVE SHOWING THE EFFECT OF STOPPING THE VACUUM PUMP

deg. fahr., its ultimate temperature would be 680 deg. In the case of a vacuum pump of this type, however, there is always entrained moisture carried in with the vapors, and the heat of compression as latent heat evaporates a certain portion of this moisture, thereby greatly reducing the sensible heat. This is noticeable in the tests reported. It is therefore entirely useless to attempt any discussion of vacuum pump efficiency without much more complete information, and also without some attempt to determine its most efficient speed of operation.

The benefit of operating upon a closed system and cutting out the air as much as possible is unquestionable; Fig. 8 shows the effect of stopping the vacuum pump of one of the Boston Elevated units. We realized from past experience that the vacuum upon the system would not suffer seriously even if the dry vacuum pump were stopped temporarily, and James D. Andrews, chief engineer of the plant, kindly consented to stop the vacuum pump on one of the units for ½ hour, making ½-minute observations of the fall in vacuum. This unit was developing 9,000 to 10,000 kw. and carrying a vacuum equivalent to 1.03 in. absolute pressure when the pump was shut down. In ½ hour the vacuum had fallen only 0.32 in., or to 1.35 in. absolute. This curve is almost a straight line between the two points. Experiments at some length will be made later, discussing the air conditions under these circumstances.

The effect of air admitted into a condenser varies greatly with the point in the condenser at which it is admitted. It may also be admitted coincident with variations in the load and quantity of steam, or the temperature, or quantity of the circulating water, all of which affect the results in a degree varying widely with the design of the condenser and the pressure lost through the condenser. The design of the condenser should restrict such losses as much as possible, but conditions of space and load will frequently determine absolutely the features of design.

THE AUTHOR. Whenever tests have been made of the kind reported in this paper, they have resulted in increased vacuum, less leakage and in showing the operating man when and where to spend money for maintenance.

Vol. 2 of Castell-Evans tables is not generally known, and I thank Mr. Foran for calling attention to Winkler's table, which will be of great value to the profession.

The volumetric efficiency of air pumps depends on two things—clearance and the number of compressions. No engineer would think of compressing air to more than five or six atmospheres in one cylinder; but in the air pump with a vacuum of 29 in. we are using 30 or more compressions with correspondingly bad results in volumetric efficiency. Without doubt, all air pumps are handling more water vapor than they should, but until we can build air cylinders with less than ½ of 1 per cent clearance we must content ourselves with poor volumetric efficiency or go to two or three-stage air pumps.

Of the ten pumps referred to in the paper, six are high-speed, single, rotative valve pumps with the Weiss bypass; two are slow-speed, two-valve pumps with what corresponds to a bypass; and two are slide-valve pumps with the Weiss bypass.

Referring to Professor Everett's criticism, the curves in Fig. 6 are drawn as straight lines. The actual curves, however, must pass near the origin, and on this account the exponent (2) is offered, pending better determination. It is very simple to leave this factor out, as Professor Everett suggests, modifying the coefficient to allow for it.

Mr. Weir's light load, little air condition is strange to us where most of the air is leakage air. Even on large units the air coming over with the feed is rarely more than 1 or 1½ cu. ft. per min., and it is very rare that the total air can be brought below 3 cu. ft. per min. Practically all turbine plants are today using open or contact heaters on the suction side of the pumps.

Replying to J. J. Brown, the air in the bell is brought to atmospheric pressure by altering the counterweight and in most cases the water in the bell has so affected the air temperature that no correction need be made for this.

Referring to Table 1, the first ten lines refer to one condenser, the next four to a second, the next two to a third and the last three lines to a fourth condenser.

Referring to his third question, the curves in Fig. 3 were obtained by starting at a low load with the best vacuum obtainable and reading the drop through the condenser.

The load was progressively increased and the drops through the condenser were taken from the same instruments. During these tests, as the load was increased the vacuum decreased slightly.

There is a correction to be made in Par. 7 of the paper where the volume of air should be noted as between 20 per cent and 30 per cent, instead of $^{1}/_{17}$ of the feedwater volume.

FOREIGN REVIEW

BRIEF ABSTRACTS OF CURRENT ARTICLES IN FOREIGN PERIODICALS

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FOREIGN REVIEW

In an early issue will be given a table for converting compound European units into American equivalents, such as cost in pfennigs per metric ton-kilometer to cents per ton-mile, calories per square meter heating surface to British thermal units per square foot, etc. It is believed that many will find such a reference table convenient. As heretofore data in the Foreign Review will be given in both the original and American units.

THIS MONTH'S ARTICLES

Among this month's articles will be found a description of various devices used for starting centrifugal pumps, and a short notice on Escher Wyss water turbines with lifts. The section on Internal-Combustion Engines contains an interesting article on spray carbureter testing giving what appears to be a practical and reliable method for testing the performances of the carbureter independently of the engine factors. Mr. Boobnov's notice on improving the reliability of naphtha engines by placing a strip of nickel in the ignition chamber is of practical interest owing to the simplicity of the device used. A. Henry's micromanometer has already aroused considerable interest in the European scientific press, owing to the simplicity of its construction and great sensitiveness: it is described under Mechanics.

While the figures in Mr. Mathot's article on the comparative advantages of using various types of prime movers in plants having waste wood available and requiring about 100 h.p. average, refer primarily to Belgian conditions and must be materially modified before being applied to similar cases in this country, they are of interest; particularly in the part referring to the gas producer and tests of a Diesel engine with Texas crude oil. In the section Steam Engineering will be found discussions on the Luminator process of feedwater purification; heat transmission in various types of economizers; description of a new type of traveling grate with undergrate blast provided with sectional air boxes, as well as of the Burkhardt type of water-tube

boiler with its interesting way of combining the boiler proper and superheater. Mr. Keppert's article on smoke damages brings out the harm done by some kinds of smoke to vegetation, as well as the means that may be taken to counteract its influence (proper fertilization of the ground in affected districts); it shows also that it is not so much the color of the smoke, as its composition, that must be considered.

There are several articles to which attention is here called in the section Strength of Materials. Professors Bach and Baumann, on the basis of a careful experimental study, show that too much power is often used in riveting machines, with the result that the sheets are stressed beyond the elastic limit, and the riveted connection is made weaker than it would have been if smaller pressure were applied. Two articles by Messrs. Preuss and Busemann report data of experiments on the distribution of stresses in punched flat bars and direction of stress in inclined plates, the interest of both articles lying in the fact that they show the usual assumption of the uniform distribution of stresses to be entirely wrong, both cases being governed by more complicated laws which are briefly stated. Professor Mesnager's method of determining in advance the stresses arising in structures by polarized light effects is interesting in that it provides for the first time a way to apply this method to complicated structures (in this case a bridge of 320 ft. span) at a moderate expense. Professor Heyn's paper, of which only a brief abstract is given here pending the publication of its complete test in the original, will be of particular interest to steam turbine engineers.

Attention is called to the section Supplementary References in which additional information is given on subjects previously treated in the Foreign Review when the information is of only bibliographic interest, or for some reason cannot be used in abstract form. Whenever possible, abstracts or translation of articles previously abstracted in the Foreign Review are mentioned in this section when they appear in other periodicals in the English language.

The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Review. Articles are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of exceptional merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

Aeronautics

DOUTRE BIPLANE (*Le biplan Doutre*, P. James. *L'Aérophile*, vol. 20, no. 21, p. 484, November 1, 1912, 2 pp., 3 figs. *d*). Description of the Doutre biplane provided with the Doutre automatic longitudinal stabilizer. *Hollow wood* is used in its construction. To *keep the steering wires from getting lax and whipping*, as they do in certain positions in the present airships, all such wires are passed over sectors of the great arc on their way to the ailerons, this arrangement not only providing a support for the wires, but also insuring rapid and certain steering. The weight of the biplane with full equipment is 600 kg (1320 lb.); speed expected 90 km (55.9 miles) per hour.

ON THE STABILITY OF AEROPLANES (*Sur la stabilité des aéroplans*, H. Mirguet. *L'Aérophile*, vol. 20, no. 21, p. 494, November 1, 1912, 2 pp., 2 figs. *dt*). Discussion of the problem of the stability of aeroplanes. The author believes that Alexandre Sée's proposal to use auxiliary planes is practical and satisfies all requirements. Mr. Sée proposes to use *separate surfaces* with the same normal incidence as the supporting planes, light and of small inertia, capable of instant displacement proportional to the effort applied, in fact such as one can see in the wings of the bird. The article describes also the Moreau Aerostable (Fig. 1) the interest of which lies in the fact that it is working, and as claimed successfully, on the principle of *pendular equilibration*. *B* is the handle of pawling; *C* lever pawl; *D* toothed sector; *E* large pinion for changing the speed from lower to higher; *F* handle of the hand brake of the pendulum; *G* pawl of the pendulum; *H* rack of the pendulum; *I* jaw releasing the rack; *K* hand release of the pendulum; *L* steering lever; *M* inertia mass; *O* countershaft for adjusting the rack; *P* storm lever; *R* double-acting rocking lever piloted at the center; *S* pendulum seat; *V* levers of the lateral ailerons.

The handling of this system is described as follows: Suppose that the seat *S* is jambed by the pawl *G* on to the rack *H*. Then by operating the handle *B* the rise and descent of the aeroplane may be effected. Suppose further that an altitude of say 600 m (1968 ft.) has been reached and maintained. The pendulum seat is then released, the right wind found, and the lever *L* set, by means of the pawl *G*, on to the sector of the toothed wheel *D* (the pawl may advance half a tooth at a time, the sector having two sets of teeth staggered with respect to each other. By means of a chain the pinion *E*, made in one piece with the lever *L*, drives the little pinion *T* fixed under the pendulum seat with its shaft carrying the little connecting rod *X* engaging with the connecting rod *Y* which in its turn transmits the motion to the lever *Z* operating the rudder. To each variation in the position of the lever corresponds a variation in the incidence of the rudder. This apparatus is efficient in ordinary weather, but in storms the oscillations may become so large as to be dangerous: in such cases the storm lever *P* is used to brake the pendulum device. Should the engine suddenly stop, the mass *M* is projected forward by its inertia, acts on the jaw *I* which lifts the rack and jambs the whole apparatus. The apparatus is said to have been used in practice and proved efficient under normal conditions of weather.

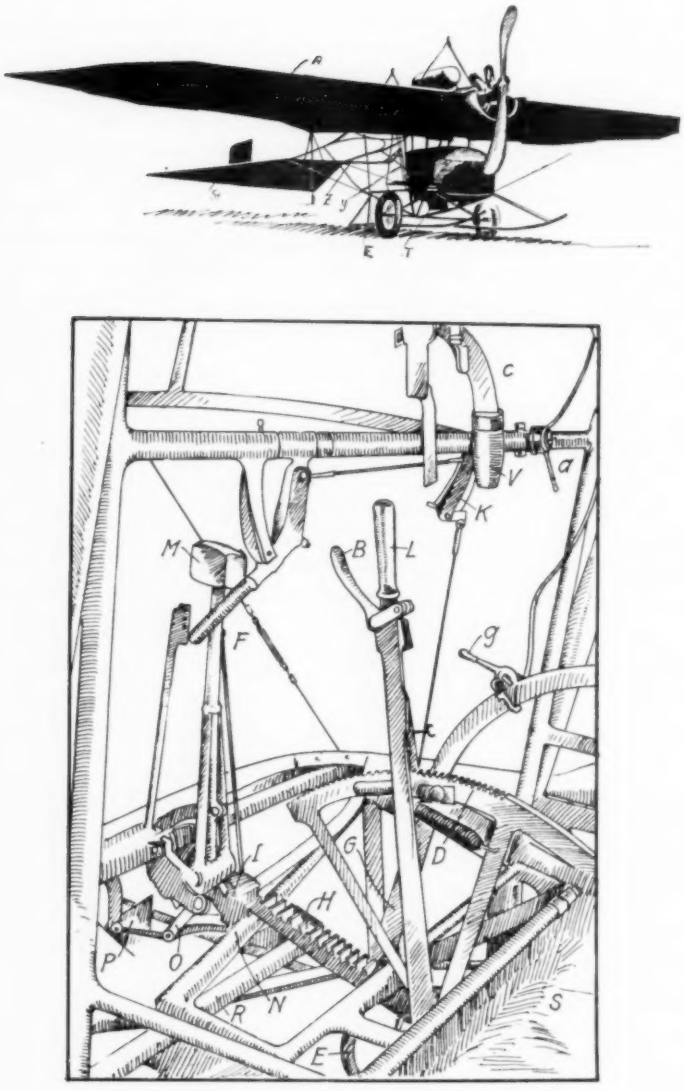

FIG. 1 MOREAU AEROSTABLE

Air Machinery

TESTS OF A TURBO-COMPRESSOR AT THE WESTERHOLT MINE. (*Untersuchung eines Turbocompressors auf der Zeche Westerholt. Glückauf*, vol. 48, no. 47, p. 1913, November 23, 1912. 3 pp., 2 figs. *dc*). Corrected data of *tests of an air compressor plant* at the Westerholt mine, Ruhr district, Prussia, from a communication of the Essen office of the Association for the Inspection of Steam Boilers. The turbine driving the compressor is so arranged as to be able to work both with live and exhaust steam, while the compressor can take in either 10000 cbm (say 35000 cu. ft.) of air per hour and compress it to 6 atmospheres gage, itself running at 4400 r.p.m., or it can run at 4200 r.p.m., and compress to 5.5 atmospheres 5000 cbm of outside air. The consumption of steam was guaranteed to be: for exhaust steam only, when handling 10000 cbm, 1.4 kg/cbm (say 0.088 lb. per cu. ft.), for 5000 cbm, 1.78 kg/cbm (say 0.112 lb. per cu. ft.); for live steam only 0.93 kg/cbm and 0.88 (say 0.04 and 0.055 lb. per cu. ft.) for the full and half load respectively. The actual test values are slightly more favorable than these. The article contains full data of the test.

Hydraulics

STARTING OF CENTRIFUGAL PUMPS (*Das Anlassen der Kreiselpumpen*, A Schacht. *Die Fördertechnik*, vol. 5, nos. 11 and 12, pp. 252 and 269, November and December 1912. 5 pp., 20 figs. *cd*). Descriptions of various devices for starting centrifugal pumps which, by their own rotation cannot create the initial vacuum required for the suction of water. The simplest method, filling the pump for the first time with water by hand, cannot be applied to large pumps or even to small pumps with long suction piping. In small house pumps a hand-driven reciprocating pump may be used for starting, or as described in the U. S. patent No. 804774, a special reservoir may be provided connected with the pressure pipe of the centrifugal pump, and having a float-valve for keeping the reservoir always full of water. For large pumps the device described in the British patent No. 17053 (Fig. 2A) may be used: the vertical pump shaft is extended downwards and carries a second blade wheel located so as to be always below the lowest level of the water and driving water up to the large pump wheel. The same patent covers also the device shown in Fig. 2B where a special reservoir is inserted in the suction piping; at starting the pump takes water from the reservoir, and thereby produces a partial vacuum in the long pipe, causing water to rise from the lower level; the device will of course work only if the reservoir and its connections are absolutely air tight. A German patent (No. 21055) covers an arrangement devised principally for dredger pumps wherein an auxiliary piping supplies water to the suction piping at such a rate that all the air is driven out of it, and it is filled with water. Fire engine centrifugal pumps (German patent No. 224223) must be started rapidly and certainly: a closed reservoir previously filled with water is emptied through the pump and produces there a partial vacuum under the action of which the suction piping is filled with water driven by atmospheric pressure. While the pump is being started, the water from the reservoir is used for fire fighting purposes, and thus not a single moment is lost.

There are several patents covering the application of the ejector principle

to the starting of centrifugal pumps, partial vacuum in the suction piping being created by a jet of steam or water. Fig. 2C shows how this is embodied in the British patent No. 25988: the water under pressure for the ejector is supplied by a little auxiliary pump driven from the main pump shaft; as soon as the main pump begins to work, the auxiliary one is cut off. Fig. 2*D* (German patent No. 216293) shows the same principle in a more complicated execution. Two centrifugal pumps are connected in series, one of them sending the water through an ejector and thus producing the suction required for starting. In practice it was found that the efficiency of high grade vacuum pumps was improved when the jet of water sent by the second pump through the ejector acted intermittently, as when the jet is shut off at short intervals of time in such a manner that separate little jets are shot out from the ejector into a nozzle; the air is then caught between the jets and expelled with greater certainty. In the arrangement shown in Fig. D, a special interrupter is provided, but another arrangement has been patented in which the part of interrupter is performed by the blade wheel of the auxiliary pump. The leading idea of the starter design in the centrifugal pump of Thyssen & Co., of Mulheim-Ruhr, Germany, (E) was to obtain a high efficiency by the use of a jet of water of large cross-section, and at the same time to protect the outlet nozzle from becoming clogged with dirt. The cold water is driven by two blade wheels into annular nozzles arranged along the periphery and comes out of them in a thin sheet which is taken up by a stationary combining nozzle and transformed into a jet; this jet in its turn acts as an ejector element in expelling the mixture of air and steam and thus producing a partial vacuum. The annular nozzles rotate at as high a speed as the friction against the wheels and water permits; particles of dirt or wood which get in can find no purchase between the stationary and rotating walls, and are rapidly ground up by the nozzle wall; this happens even with long wooded chips 4 mm (0.16 in.) thick. The construction of Gustav Bölte in Oschersleben (F) patented in Germany (No. 239345) is particularly adapted to vertical pumps. The gas and liquid flow axially which allows the gas and liquid ducts to run side by side without intersecting; the ducts for the liquid may be, e.g., bent backward, while those for the gas forward or radially. On the horizontal wall *a* of the runner the axially directed outlets of the gas ducts *b* and liquid ducts *c* alternate, the liquids acted on by the pump reaches the ducts in the nozzle body *d*, and sucks with it gas through *b*, gas and liquid pistons in *d* following one another. The gas collects in *e* and escapes through *f*, while the liquid returns to the suction side of the ducts. The space *e* should be large enough to permit the water to absorb the air; there is further a tendency for the water to heat up and start evaporating: these appear to be the disadvantages of this construction.

The article describes also the devices of Delahaye, Rateau, and Koerting, known in this country, and those covered by the U. S. patents Nos. 820779 and 819237 which do not need abstracting here. Mention is made of a device known as Hydraulic Air Pumps Patent Scholl and manufactured by Böckel & Co., Mannheim, Germany, in which water under pressure is used for the evacuation of air, the air pump being automatically cut out as soon as the centrifugal pump begins to work; this device is described only in a very cursory manner.

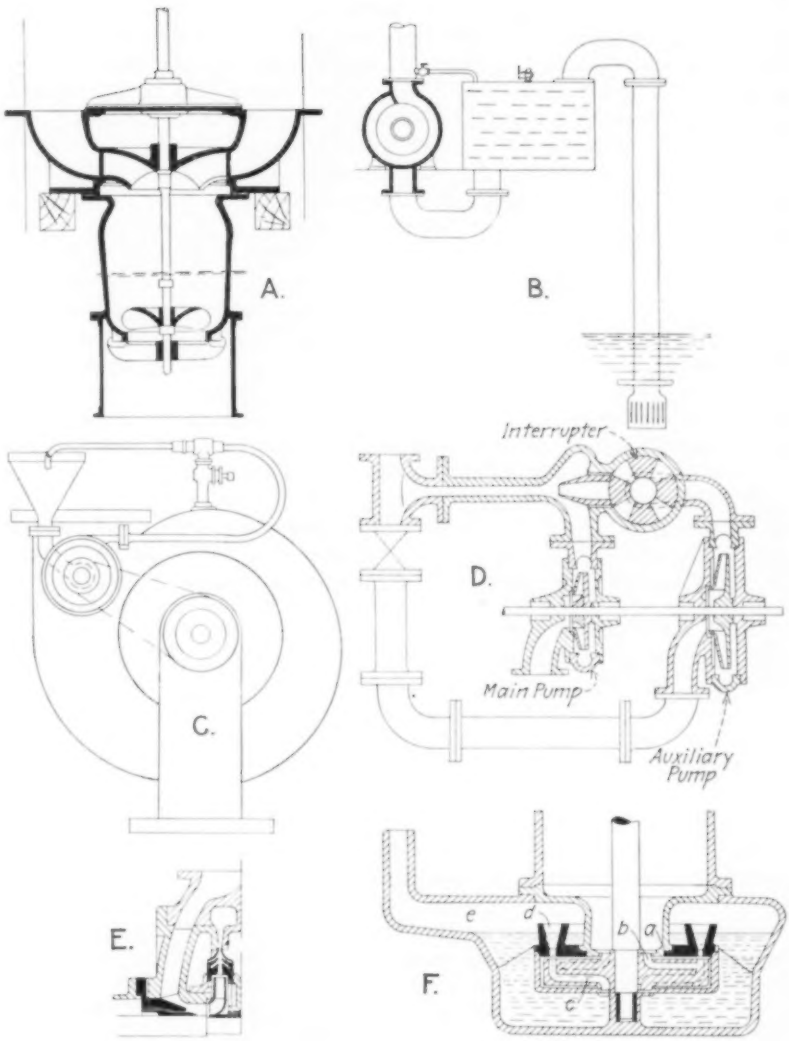

FIG 2 DEVICES FOR STARTING CENTRIFUGAL WATER PUMPS

WATER TURBINES WITH LIFTS (*Wasserturbinen mit Heber*, H. Keller. *Die Turbine*, vol. 9, no. 5, p. 80, December 5, 1912, 3 pp., 3 figs. *d*; same in French in *Génie Civil*, vol. 62, no. 5, p. 92, 1 p., 1 fig. *d*). Description of the Escher Wyss & Co. system of turbine plant construction used in cases where it is desirable, with a usually low head of water, to have the driven machine, say the generator, directly connected to the turbine, and at the same time protected from flooding at high water. To do this, the axis of the turbine is placed near the high water level, the water being raised by special lifting apparatus. The artificial drawing off of the air by suction by means of the suction pipe of the turbine itself is one of the characteristics of this system. The apparatus described is not new, plants having been installed on this system as early as 1908. No data as to the amount of power required to withdraw the air or as to the general efficiency of the plant are given in either of the two articles.

GRAPHICAL REPRESENTATION OF THE WORKING PROCESSES IN CENTRIFUGAL PUMPS (*Darstellung der Betriebsvorgänge bei Kreiselpumpen*, H. A. Janssen. *Zeits. des Vereines deutscher Ingenieure*, vol. 56, no. 47, p. 1895, November 23, 1912. 6 pp., 9 figs. *tA*). Starting with the well-known graphical methods for determining in case of centrifugal pumps the mutual relation of the number of revolutions, delivery head, output and efficiency, the author shows how it may be also applied to the determination of the power of the driving engine, its moment of torsion and specific output, as well as how such diagrams may be used. He also draws diagrams showing the working process of any centrifugal pump of given construction as far as the mutual relation of the above named variables is concerned. Several numerical examples are given to illustrate the author's methods.

Internal Combustion Engines

SINGLE-SCREW MOTOR SHIP "ROLANDSECK" OF THE GERMAN NAVIGATION COMPANY "HANSA" (*Einschrauben-Motor-Frachtschiff "Rolandseck" für die Deutsche Dampfschiffahrts-Gesellschaft "Hansa,"* C. Kielhorn, *Dinglers polytechnisches Journal*, vol. 327, nos. 49-50, pp. 772 and 791, 6 pp., 5 figs. *d*). Description of a Diesel engine freighter. Cp. *The Engineer* (London), November 22, 1912.

HIGH-SPEED DIESEL ENGINES (*Moteurs Diesel à marche rapide*, Prof. G. Supino. *Electro*, vol. 11, no. 11, p. 167, November 1912, 3pp., 2 figs. *c*). Data of experiments made by the author at the Royal Engineering School, Milan, Italy, with a Langen & Wolf high-speed Diesel engine; of interest in view of the controversy as to whether high-speed Diesel engines are practical or not. The author found (data from one of the 7 tests reported in the article are used in this abstract) that with 378 r.p.m. the engine developed 79.5 e.h.p. at the shaft, with a consumption of 206 grams (0.45 lb.) of fuel per e.h.p-hr. Heavy oil was used as fuel, of density 0.93, and heat value 10200 calories (18360 b.t.u. per lb.).

POWER GAS PRODUCERS FOR LIQUID FUELS (*Kraftgaserzeuger für flüssige Brennstoffe*, Gwosdz. *Die Gasmotorentechnik*, vol. 12, no. 9, p. 137, December 1912, 3½ pp., 7 figs. *d*). Description of gas producers for liquid fuel; only American types are described.

2000-H.P. Gas Blowing Engine (2000-*PSc Gasgebläsemaschine*, Ed. Kaschny. *Zeits. für Elektrotechnik und Maschinenbau*, vol. 15, no. 50, p. 533, December 11, 1912. 2½ pp., 1 fig. and 1 sheet of drawings. *d*). Description of the Maschinenfabrik Augsburg-Nürnberg type of large gas blowing engine for which a very high degree of reliability is claimed.

Indicator for Spray Carbureters (*Indikator für Einspritz-Vergaser*, G. Bergman. *Der Motorwagen*, vol. 15, nos. 17, 21, 29, 31, 33, pp. 431, 515, 671, 713, 757, June 20, July 31, October 20, November 10 and 30, 1912. *deA*). For a general discussion on the subject of carbureter tests see *Some Tests on Carbureters*, by George W. Munro, *The Journal*, March 1912, p. 343, and *discussion* of same in *The Journal*, August 1912, p. 1208. The imperfection of the method applied to the test of carbureters lay, however, in the fact that, as pointed out by Mr. Munro, the carbureter is used only in connection with an engine and has to be tested in use upon it, thus introducing engine characteristics into all results, while on the other hand, the performance of the engine cannot be determined free from carbureter factors. The article of Mr. Bergman shows a way to arrive at the determination of the carbureter characteristic practically independent of that of the engine to which it is attached. The basic characteristic of the method applied is the use of a carbureter which, in addition to the usual fuel port, is provided with a measuring opening of the same form and arrangement, but with mechanically operated opening and closing. The manometer attached to it is therefore connected with the interior of the carbureter only during the period when the valve gear leaves the respective passage open, and registers only that phase of the process in the carbureters which corresponds to the particular moment under investigation. By changing the moment of opening of the carbureter by suitable adjustment of the valve gear so as to register phase after phase, the entire series of pressure variations may be ascertained. The reliability of this process is shown by Fig. 3A which is made up of 17 superimposed diagrams: variations are of a purely local character, and so slight that they affect neither the area of the diagram, nor the shape of the curve expressing the law of pressure variations in the carbureter. The carbureter as used for these tests is shown in Fig. 3B. The mixing chamber is tube-shaped; the fuel pipe crosses it normally to the direction of the air current, and may be displaced axially by a screw arrangement shown in the drawing; the position of the fuel pipe may be read on a special scale attached to a stirrup screwed on the fuel pipe. This stirrup runs in guide-blocks; according to its displacement, the fuel pipe rotates, thus producing variations of the angle between the fuel and measuring openings on one hand and direction of the air stream on the other. The measuring opening is regulated by means of a rotating inside slide valve. As long as a certain phase of the process is being investigated, especially in regard to its functional relation to various regulations of the engine to which the carbureter is attached, the slide valve is made to rotate at the same speed as the engine, and the port in the valve and the measuring opening are made to superimpose always at the same position of the piston. The slide valve may be set so as to correspond to any desired position of the piston. When the slide valve rotates somewhat slower than the engine shaft, the carbureter

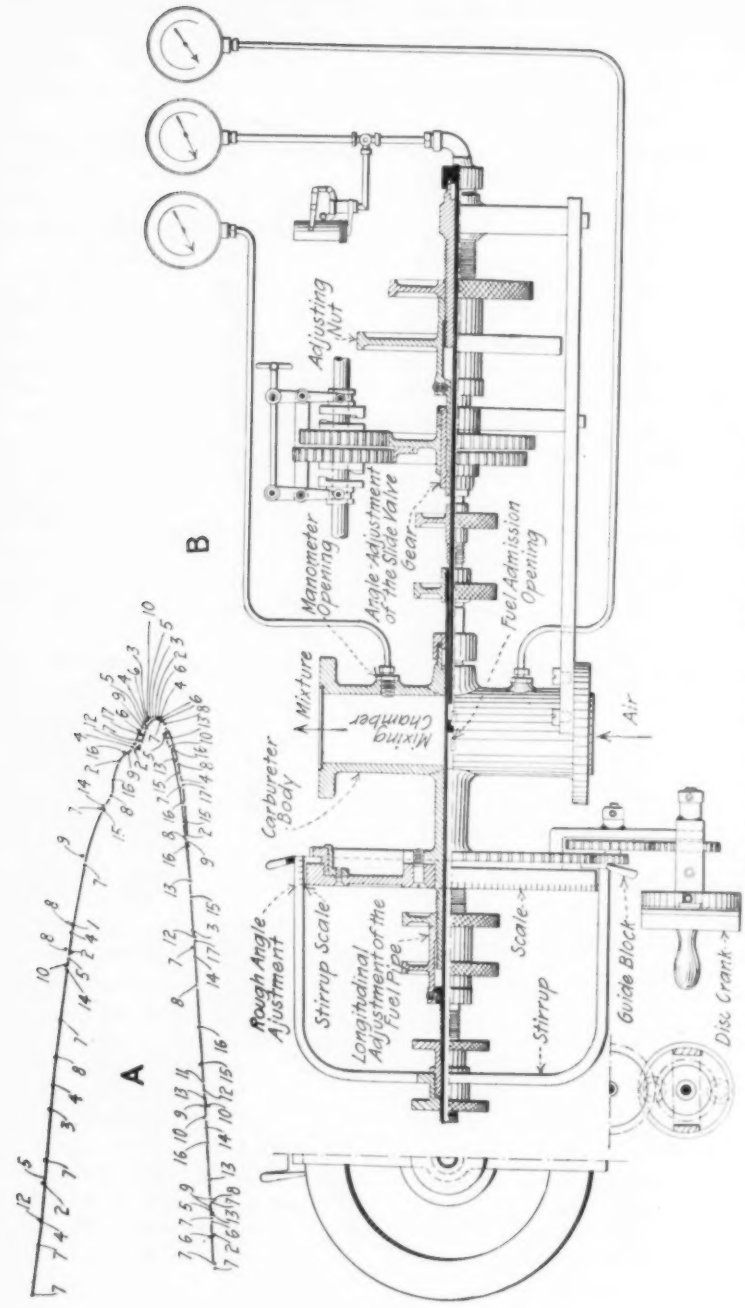

FIG. 3 CARBURETER INDICATOR AND DIAGRAMS

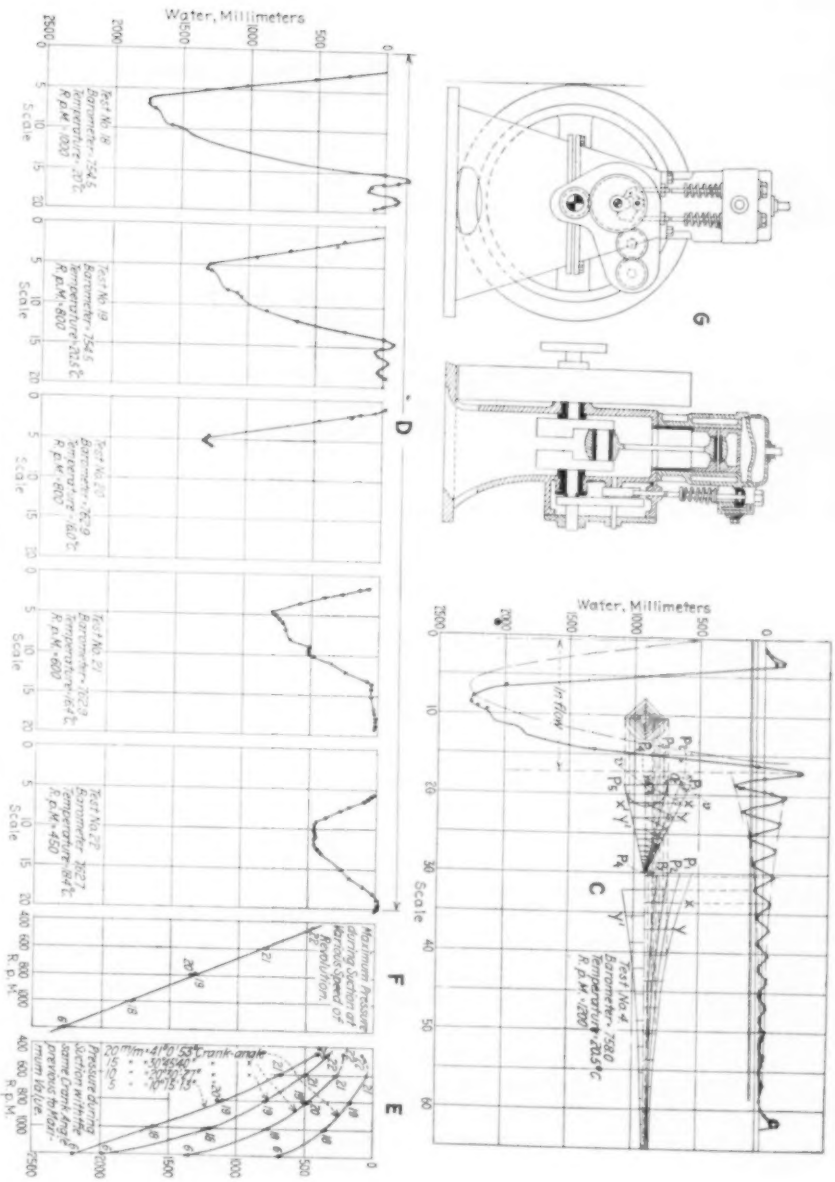

FIG. 3 CARBURETER INDICATOR AND DIAGRAMS

pressure registered represents different phases for each revolution, while the average pressure may be obtained by placing the slide valve opening opposite to the measuring, and making the slide valve stationary. This arrangement proved to be very convenient; the presence of the slide valve did not interfere with the free working of the carbureter, and produced neither eddies nor additional oscillations in the gaseous mass, while all the phenomena which affect the performance of the fuel nozzle act in the same way with respect to the measuring opening, and are registered by the manometer.

Fig. 3C gives the *carbureter diagram. Back pressure of exhaust-gas products.* The inlet valve rises after the upper dead center *OT* is passed; the opening moment is marked *EO*; there is still an underpressure in the cylinder, resulting in a pressure surge in the carbureter. During the action of the back pressure of exhaust-gas products the motion of the piston accelerates (its velocities are indicated on the diagram by dotted lines); the gases in the cylinder expand, and the pressure surge rapidly goes down, this return movement being still more intensified by the inertia of the gas column which must first change its direction of motion in order to follow the piston: owing to this, the curve is much sharper than that of the piston velocities. After the piston passes through its maximum velocity, its motion begins to retard, but the gas motion, i.e. pressure variation, still continues in the former sense. When therefore the piston reaches its lower dead center (UT_1 UT_2), the gas column still continues to flow as before, the pressure rises above atmospheric and the valve begins to close (the pressure above atmospheric in the cylinder is actually somewhat less than in the carbureter diagram). The course of the charging impulse depends on the regulation of the admission; in the main it ought to follow the piston velocities, provided they are drawn to a correct ordinate scale. The irregularities which appear in Fig. 3 are due to resistances in the piping and valves, or lost motion in the valve gear.

The engine attached to the carbureter was electrically driven as an air pump, at an average speed of 1200 r.p.m., but actually varying from 1190 to 1210. The diagrams taken are shown in Fig. 3D, where the various curves vary only in the ordinate scale, but otherwise belong to the same family, or are derived from the same function preceded by different coefficients depending on the number of revolutions n:

$$f_n\ (2x) = c_n\ f_{no}\ (2x)$$

where f_{no} is the impulse function. This equation shows that all corresponding points or phases of two diagrams are in the same ratio of ordinates (proportionality of ordinates). If the ordinates of respective points of the diagrams be plotted as functions of the speed (Fig. 3E), the chords of all the curves will intersect in the same point. Deviations from this law may be due to irregularities of working, variations in resistance of flow, or resonance phenomena. In Fig. 3F the peaks of the curve are plotted as functions of the number of revolutions, and the pressure deflections are found to be proportional to the speed. This law holds good only within the range of speed used in this case, and undergoes material changes at considerably higher speeds. Pressure surges decrease more and more as the speed decreases.

Altogether the above diagrams show that the character of the suction impulse as expressed by the equation

$$p = c_n \cdot f_{no}\,(2x)$$

is fairly well able to oppose all ordinary influences tending to alter it; artificial regulation, such as throttling, changes the shape of the curve, as the author shows in a further set of curves.

While this part of the article, as well as that referring to errors due to the measurement of the air in the investigation of the processes occurring in the carbureter cannot be abstracted here owing to lack of space, attention is called to the fact that the author's method gives a practical and certain way for investigating the efficiency of carbureters and valve gears; the author claims that even the slightest irregularities in the valve gear action may be thus detected and traced to their origin.

CAUSES OF IRREGULARITIES IN THE WORKING OF TWO-STROKE CYCLE NAPHTHA ENGINES AND THEIR ELIMINATION (*Prichiny kaprizov dvookhtaktnykh neftyanykh dvigateley i ikh oostraneniye, Dvigatel*, vol. 6, no. 21, p. 353, 1912. *p*). Mr. B. A. Boohnov, of the Kiev Polytechnic Institute, Russia, states that small two-stroke cycle naphtha engines find a wide application in the industry in Russia, but their still larger spread is prevented by frequent irregularities of working, such as loss of power, loss of economy of operation, and, what is the most annoying, stoppages. The general construction of the engine is so simple that trouble could be looked for only in connection with the ignition chamber, and the writer both from his own investigations and tests made at some of the exhibitions of internal-combustion engines recently held in Russia noticed that sometimes not enough heat is developed during the working of the engine, with the result that products of incomplete combustion are formed and deposited on the inner surface of the ignition chamber in the form of coke; this coke reduces the thermal capacity of the ignition chamber and thereby causes irregularities in the working of the engine. The author claims to have eliminated this tendency by the use of what he calls a *catalyst*, in this case an element of high specific heat, to promote more complete combustion. There were three metals that could be so used: platinum, copper and nickel, but platinum is too expensive, and copper volatile; nickel was therefore used, a strip of it being placed on a wire of the same metal in the ignition chamber (the wire was used in order to reduce direct contact between two bodies of different specific heats). This increased the efficiency of the engine and economy of operation, and eliminated smoke and uncalled-for stoppages of the engine. No data as to the size of the nickel strip are given, the author simply stating that he determined it by guessing, as he could find no information in the literature as to what it should be. The strip is called a catalyst because it accelerates the process (in this instance that of combustion) without actually taking part in it.

Mechanics

MICROMANOMETER (*Micromanomètre*, A. Henry. *Comptes Rendus des séances de l'Académie des Sciences*, vol. 155, no. 22, p. 1078, November 25, 1912. 2 pp., 1 fig. *d*). This manometer is a modification of that of Kretz. The author noticed that the latter grew more sensitive as the

densities of the two liquids approached each other, and substituted for the two liquids a single one, with an air bubble inside, at *b* (Fig. 4). The bends *C* and *C'* serve to keep the air bubble from escaping. It has been found that the friction between the air bubble and the surrounding media, when the apparatus is properly arranged, is extremely small. Water cannot be used as the liquid because it attacks the glass, and produces a rough surface of contact for the air bubble. The most convenient liquid to be used was found to be carbon tetrachlorate, which is but slightly viscous, possesses a low surface tension, is not affected by air, and is not inflammable. The apparatus is extremely sensitive: the author in his tests has found that it may be relied on to indicate a variation of pressure of 1/200 mm (say 0.0002 in.) of water. In one of the apparatus a variation of pressure of 0.5 mm (0.0197 in.) of water produced a displacement of the air bubble of 120 mm (4.71 in.), with a probable error not exceeding

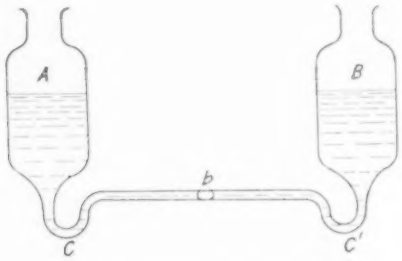

FIG 4 HENRY MICROMANOMETER

1 per cent in the estimation of a pressure of 0.5 mm (0.0197 in.) of water.

Power Costs and Fuel

CRITICAL STUDY OF AN INSTALLATION OF A POWER PLANT OF 100 H.P. IN A FACTORY HAVING LARGE QUANTITIES OF WOOD WASTE AVAILABLE (*Etude critique d'une installation de force motrice de 100 chevaux dans une usine disposant de déchets de bois en grande quantité*, R.-E. Mathot. *La Technique moderne*, vol. 5, no. 12, p. 439, December 15, 1912. 4 pp., 2 figs. *ccp*). Investigation of the problem as to the kind of prime mover that would be the most convenient for a factory requiring about 100 h.p. and having large amounts of wood waste. A steam engine would not be economic because its combustion is fairly rapid, and special attendance would be required to shove the wood shavings and chips into the furnace; besides, the amount of wood waste would probably be insufficient to feed the engine, and additional coal would have to be used, thus increasing the cost of power. An anthracite gas producer does not use the wood waste at all, but requires a rather expensive fuel. A much better plan would be to use a special gas producer for the burning of wood waste, such as the Crossley type. The author gives full data of the Crossley gas producer and producer engine for use of wood waste showing that 1.20 kg (2.64 lb.) of wood waste is burned per e.h.p-hr., though this consumption may rise to 1.50 kg (3.3 lb.) per h.p-hr. with very wet wood. When burned in a steam

boiler furnace, the same material would be burned at the rate of 3 to 4 kg (6.6 to 8.8 lb.) per h.p-hr. Under Belgian conditions the cost of running a Crossley gas producer plant would be as follows (with the initial price of the installation for 100 h.p. at 30,000 fr., or roughly $6000):

	Fr.	$
Interest and depreciation in 10 years at the rate of 13 per cent per year on 30,000 fr./$6000	3900	780
Maintenance at the rate of 4 per cent of the cost of the engine and gas producer alone (25,000 fr./$5000)	1000	200
Attendance: One engineer	1500	300
One helper to load the waste into the furnace	700	140
Combustible (wood waste)	No cost.	
Lubrication	300	60
Various minor expenses	200	40
Total	7600	1520

Or at the rate of 60 h.p. average during 300 days at 10 hours per day, the cost per e.h.p-hr. comes to fr. 0.042, or $0.0084, which, at least under Belgian conditions, is more economical than using a Diesel engine with tar-oil at 8 fr. per 100 kg ($14.6 per short ton).

The second part of the article gives a brief description and some data of tests of Diesel engines built by the Swedish Diesel Engine Company of Stockholm (Aktiebolaget Diesels Motorer) and provided with Hesselman atomizers (for a description of the Hesselman Atomizer see *The Journal*, March 1912, p. 417). During these tests the number of revolutions was registered for each load by means of an integrating speed-counter; the fuel consumption was determined by using instead of the usual fuel tank a special tank with the fuel previously weighed; the length of each test measured by a chronometer; cooling water consumption determined by a meter; indicator diagrams were used to control the conditions of the test, but the action of the indicator could not be controlled sufficiently to make it possible to use the diagrams for determining the power indicated and the mechanical efficiency.

The first of the engines, having three cylinders, was loaded by means of a Heenan and Froude hydraulic brake.

Texas crude oil was used, having a density of 0.885 at 18 deg. cent. and 2.2 per cent of non-combustible matter. The other engine tested was a single cylinder engine, with German tar-oil used as fuel.

The following data have been obtained (the original article contains data from five tests of the motor *A*, and four tests of the motor *B*: only two tests for each engine are quoted here): *A* is a three cylinder 135 h.p. using Texas crude oil; *B* a one cylinder, 45 h.p. engine, using German tar-oil.

	Engine *A*.		Engine *B*.	
Test No.	1	2	1	2
Length of test, min.	60	30	30	30
Load	full	half	full	half
Brake load in kg/lb.	157/344	77.5/172	97.7/214	49.7/109.4
R.p.m.	266	272.7	268	273.2
Work at the brake, e.h.p.	139.18	70.7	45.3	23.5

Oil: Total consumption, kg/lb.	25.3/55.6	6.91/15.22	4.38/9.66	2.85/6.25
Per b.h.p-hr., gr/lb.	181.7/0.4	196.5/0.435	193/0.425	242.5/0.535
Cooling water per h.p-hr., l/gal.	10.7/2.78	13.1/3.41		
Temperature of water at leaving engine, deg. cent./fahr.	60/140	58/136.4	64/147.2	69/156.2
Compression in the cylinder, kg per qcm/lb. per sq. in.	39/555		41/583	
Thermal efficiency	0.325		0.346	

These tests have shown the possibility of overloading the engines 23 per cent above normal load. The consumption is remarkably low, especially in the case of the small engine to which tar oil was delivered by a single pump, without admixture or preheating.

The author gives the following data as to the cost of running a 100-h.p. Diesel engine of the Polar-Diesel type, delivering on an average 60 h.p. (under Belgian conditions); the prices are in fr./$, taking $1 = fr. 5:

TABLE 1. COST DATA, 100 H.P. POLAR-DIESEL ENGINE

	Fr.	$
Interest and depreciation at the rate of 13 per cent per year on 29,000/5800	3770	754
Maintenance charges at the rate of 4 per cent per year of cost of engine (27,000/5400)	1080	216
Attendance: One engineer	1500	300
Fuel, at the rate of 190 grams (0.42 lb.) per h.p-hr., at 8 fr. per 100 kg ($14.6 per short ton), for 60 h.p. 300 days at ten hr. a day	2736	547.2
Lubrication	300	60
Various minor expenses	114	22.8
Total	9500	1900
Per h.p-hr.	0.0527	0.0105

The author shows in another table that the cost of power with a gas producer of the suction type would be only fr. 0.0427 ($0.0085) and therefore from the point of view of economy would appear to be the most advantageous; the Diesel engine presents, however, important advantages in the small floor space that it takes, its reliability of operation, ease of handling the fuel, absence of smoke, etc. and is an ideal prime mover where the cost of fuel is of but secondary importance.

COAL STORAGE AND COSTS (*Über Kohlenlagerung und ihre Kosten*, R. Nübling. *Journal für Gasbeleuchtung*, vol. 55, nos. 49 and 50, pp. 1193 and 1222, 7 pp. 7 fig. and 2 sheets of drawings. *p*). General discussion of the question of coal storage containing a good review of the literature of this question, mainly German. A bibliographic list is appended, as well as several tables showing the loss of gas production and heat value of coal as a function of the length of storage. Bibliography appended.

Steam Engineering

"LUMINATOR" AS BOILER SCALE PREVENTIVE ("*Luminator*" *gegen Kesselstein*, E. E. Basch. *Chemiker-Zeitung*, vol. 36, nos. 148 and 150, pp. 1435 and 1461, December 10 and 14, 1912. 3 pp. *gt*). Critical discussion of the "*Luminator*" *process for removing boiler scale* (for description of this process see *Society of Chemical Industry*, vol. 31, pp. 57-60, 1912, and vol. 30, pp. 933 *f-f-*). The author analyses various theories presented by

different writers for the explanation of this process, as well as its efficiency, and finally concludes practically as did the Prussian Ministry of Industries and Trade, which stated in its report for 1910 that the Luminator process "belongs to the class of apparatus in the experimental stage. As long as it is not explained what is the cause of its action, its results must be considered as accidental." The author denies the possibility of the aluminum particles being torn off the plate and acting on the particles of matter forming the scale, and says that in 1907 he had seen in Hamm i.W., Germany, an installation for the extraction of iron from feedwater in which the water containing considerable amounts of iron was passed through a heap of beech branches and then treated in the usual manner by aeration and filtration, with the result that when fed to the boiler, it produced plenty of sediment, but no hard scale. He concludes therefore, that there are certain kinds of water which may be cleaned by simple driving through any material whatever, but that the aluminum particles have no part in producing this result, even if it were known that there were any in the water treated by the Luminator process which, the author states, has not yet been proved. He is inclined to classify the action in the Luminator process among phenomena analogous to the case of a supersaturated solution in a state of unstable equilibrium being transferred to the state of stable equilibrium by introducing into it what is known as ion. In the Luminator process tiny crystals of calcium carbonate which reach the boiler from the Luminator plate act as the ion.

As to the behavior of the most important element of feed water, as far as the formation of scale is concerned, viz. calcium sulphate in luminated water, Dr. Hilliger states that owing to the application of the Luminator process, gypsum can remain in solution up to that concentration at which it automatically separates out owing to supersaturation; according to the author, however, Dr. Hilliger takes the concentration limit too high, since in a closed boiler all gypsum ought to separate out at temperatures varying according to different authorities from 140 to 150 deg. cent. (284 to 302 deg. fahr.). In a tubular boiler in which the entire water is evaporated at least once in 12 hours, the formation of gypsum scale would therefore begin after a single day of operation.

The author believes therefore, that, taking all conditions into consideration, the Luminator process will give a scale-free boiler running only in exceptional cases, and even then the formation of sediment instead of scale is not always quite desirable since it may lead to the clogging of boiler fittings, and overheating and outward bulging of boiler sheets. Besides the only reliable way to remove sediment is by frequent and generous blowing out of the boiler, and that involves considerable losses in heat and boiler water.

The author severely criticises the tests lately made in Vienna by the Society for the Inspection and Insurance of Boilers at the demand of the Austrian Patent Office which have shown that with the Luminator process applied fully (aluminum plate and solar light) only 1/5 of the scale formed without it has been found in the boiler; when the process was used only partly (aluminum plate, but no solar light) twice as much scale was formed as when the process was fully applied. The author analyses

the methods of conducting these tests, and concludes that the boilers were working under conditions quite unlike what they would be subjected to in actual practice, while it was even possible that the addition of water after the drawing of the fire might have produced the loosening of some of the scale (he does not explain, however, why this should happen in the case when the Luminator process was applied). The question as to whether the light has anything to do with the efficiency of the process is not considered by the author. A full bibliography of this process has been prepared by the Library of the Engineering Societies.

On the Influence of the Material and Thickness of Walls of Economizer Pipes on the Utilization of Heat (*Über den Einfluss des Materials und der Wandstärken von Ekonomiserrohren auf die Wärmeausnutzung*, M. R. Schulz. *Braunkohle*, vol. 11, no. 37, p. 590, December 13, 1912, 3 pp., 1 fig. *cp*). Critical discussion of Mr. Hanff's paper abstracted in *The Journal*, November 1912, p. 1893, with Mr. Hanff's rejoinder. The author claims, on the basis of tests made by the Bavarian Association for the Inspection of Steam Machinery that circulation economizers require from 10 to 15 per cent less economizer surface than e.g., Green economizers, and that consequently even with cast-iron economizers the water velocity plays an important role, a fact not taken into account by Mr. Hanff. The author claims also that Mr. Hanff's formula cannot be applied equally well to wrought-iron and cast-iron economizers, since entirely different assumptions are made in the design of the former; the coefficient of heat transmission in the Schulz economizer has been found to be nearly twice as high as in cast-iron economizers. The main point however is what amount of heat is transmitted through a unit of surface of the economizer, and this question is answered by the curves in Fig. 5 taken from the author's book "*Über Ekonomiser*." These curves have been traced on the basis of the following considerations: the absorption of an economizer is a function of the temperature of the flue gases at the economizer entrance, and the velocity of the gases; there are therefore four curves; two for natural draft and two for forced, because in the latter case the heat transmission may be increased by raising the velocity of the flue gases.

Traveling Grate with Undergrate Blast (*Ein Wanderrost mit Unterwind*, Pradel. *Zeits. für Dampfkessel und Maschinenbetrieb*, vol. 35, no. 50, p. 535, December 13, 1912, 3 pp., 7 figs. *d*). The usual arrangement of traveling grates with undergrate blast is imperfect, according to the author, in that, unless the grate bars are very close together, small sized fuel cannot be used at all; in addition with the grate moving over a stationary air box in a fixed position and provided only with a few openings at the top, there is always a tendency for the ashes to gather at the top of the grate, and to hinder free access of air. The grate recently placed on the market by the Deutsche Unterschub-Feuerungs-Gesellschaft m.b.H., of Mannheim, Germany, is said to have obviated all these difficulties by the use, instead of a built-in air box, *of sectional air boxes* fed from the side, and formed from below by a special plate, and on the other sides by the grate plates and grate plate supports. There is therefore what amounts to a separate air box under each grate plate, fed with air from the side, and traveling with the grate; these air boxes are further arranged in such a

manner that air is supplied only to those parts of the grate where combustion takes place; the beginning and end of the grate receive no air blast, and are strongly cooled, with a further possibility of regulating the cooling so as to suit various kinds of fuel. This grate is particularly adapted for *low priced fuel*, such as coke breeze, fine coal, etc.

CONTRIBUTION TO THE ESTIMATION OF SMOKE DAMAGES IN THE RHINE-WESTFALIAN MANUFACTURING DISTRICT (*Beiträge zur Beurteilung von*

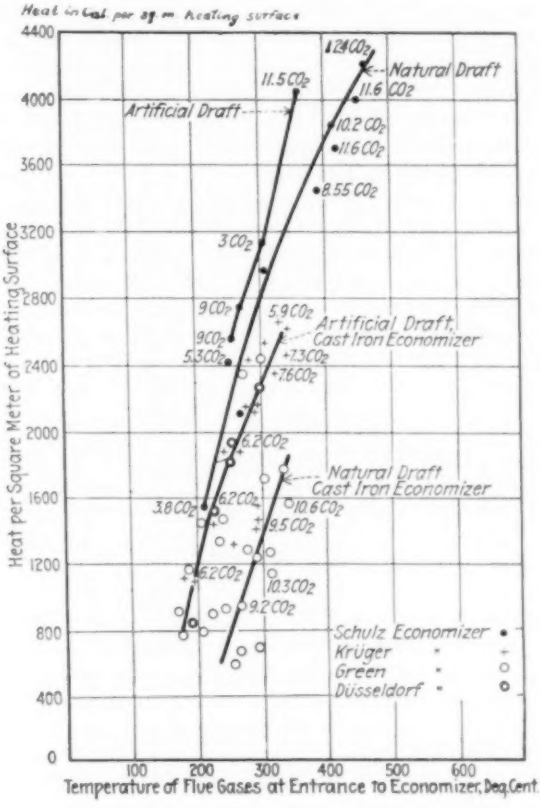

FIG. 5 ECONOMIZER CURVES

Rauchschäden im rheinisch-westfälischen Industriegebiet, P. Kippert. *Glückauf*, vol. 48, nos. 49 and 50, pp. 1992 and 2026, December 7 and 14, 1912. 18 pp. *gs*). A comprehensive discussion of the smoke problem as applied to the Rhine-Westfalian manufacturing district. The important point this investigation brings out is that, as far as vegetation is concerned, it is not the solid particles of the smoke that are primarily injurious, but the gaseous, which may be by careful treatment made invisible enough to satisfy the smoke inspector, e. g. vapors of sulphuric acid from locomotives, hydrofluoric acid from brickmaking plants, etc. The author's own

investigations have further shown that sometimes trees and plants are injured by the smoke and fumes although the amount of sulphuric acid present in the atmosphere appears to be insignificant; this is explained by the claim that only a small part of the H_2SO_3 emitted from the furnaces stays in the air, while its major part finds a way into the ground. Therefore in the neighborhood of industrial plants and manufacturing cities the ground is generally supersaturated with sulphuric acid which reaches it first in the form of sulphurous acid and is converted into sulphuric by oxidation with atmospheric oxygen. The harm of its presence lies in the fact that it converts calcium carbonate into calcium sulphate or gypsum, thus producing "delimation" (*Entkalkung*, decrease in the contents of calcium carbonate) which gives the ground an acid reaction and makes it unsatisfactory for plant growing purposes. This has been fully proved by the experiments of Wieler: a plot of ground on which all useful vegetation had been destroyed by the action of fumes from a silver smelting plant was cleaned of weeds and planted with pines; one part was left in its original state and the other fertilized by material rich in calcium carbonate. At the end of the third year the pines on the unfertilized plot died, while those on the fertilized developed normally. The article contains also other valuable data on the influence of smoke and fumes on plant growth, showing among other things that there may be cases where the presence of an excess of sulphurous acid in the air affects the plant growth favorably.

New Steam Boiler Constructions in Steam Turbine Plants (*Neuere Dampfkesselkonstruktionen für Dampfturbinenkraftwerke unter besonderer Berücksichtigung der Steilrohrkessel*, Fr. Münzinger. *Zeits. für das gesamte Turbinenwesen*, vol. 9, no. 34, p. 538, December 10, 1912. 4 pp., 11 figs. *d*). Continuation of a series of articles on new types of steam boiler construction, including the description of the *Ketzer boiler* made by H. Ketzer in Duisburg, Germany. The boiler proper is much like the Stirling boiler, with the difference, however, that the upper drums are connected by means of standpipes of large diameter. The superheater starts at the front-end plate and is arranged so that its coils pass through every second nest of the boiler tubes; as a result each row of water tubes is in proximity with a free nest of tubes, and the exchangeability of the water tubes is not affected. Should a superheater coil have to be removed, its free ends are pressed somewhat apart, whereupon it can be passed between the superheater steam collectors. An interesting type is also the Burkhardt boiler made by J. Piedboeuf in Düsseldorf, Germany (Fig. 6) in which one organic unit is made of the boiler and superheater as far as possible. Its four drums are connected in pairs by bundles of tubes having 51 mm (2.00 in.) external diameter; in these tubes the steam is generated, the water flowing back through larger tubes located along the outside shell of the boiler proper. The circulation of water follows therefore two independent but intersecting paths; in the upper boiler, above the ascending pipes, is placed a longitudinal plate to keep the circulation of water steady and to prevent violent variations of the water level. There are 7, 9 or 11 water tubes in one plane, their curvature being so proportioned that they may be removed when necessary through small

holes in the jacket of the upper boiler; these holes serve also to clean the pipes without entering the boiler. The hot gases rise slowly in the high combustion chamber and transfer their heat mainly by radiation, while baffle plates made of refractory clay take care that all the tubes receive their due amount of heat. At the intersection of the nests an additional amount of heat is extracted from the gases by conduction owing to the strong formation of eddies. The gases then flow downwards, and, with a sharp change of direction, on to the two preheaters and smokestack. The two sharp changes of direction of flow of the gases help to shake out the ashes which settle down and can be conveniently removed through the dampers. The system of baffling the hot gases is interesting in that it is arranged so that the warmer gases are nearly always surrounded by layers of somewhat colder gases, thus materially decreasing radiation losses which are further decreased through the hottest gases being nearly always in immediate touch with the heating surfaces. The boiler shell is made of wrought-iron walls lined with fire clay and consisting almost entirely of flap doors; this increases the accessibility to the boiler and facilitates the cleaning of the economizer, an especially welcome feature as there are no mechanical appliances for this purpose. The preheater can be blown through by steam or compressed air even during the operation of the boiler, by means of nozzles rolled into the upper header. The superheater is placed inside the tube nests, and is in the same path of the hot gases as the water tubes, thus permitting a very strong superheating with a comparatively small surface of superheater, and the attainment of a high steam temperature at low loads. The hot gases flow through side openings in the brickwork shaft where the superheater is located, pass by it and come back to the boiler flues; rotary valves being provided to regulate the admission of the hot gases to the superheater coils. By a steam collector of generous size the steam is kept dry even with a strong demand on the heating surface. The article mentions tests made by Professor Langer and some organizations, but does not give any data.

Strength of Materials and Materials of Construction

TESTS FOR THE ELUCIDATION OF THE INFLUENCE OF THE STRESSES WHICH ARE PRODUCED IN THE MATERIAL BY RIVETING AND MAY LEAD TO THE SPLITTING OF RIVET HOLES (*Versuche zur Klarstellung des Einflusses der Spannungen, welche durch das Nieten im Material hervorgerufen werden und die der Entstehung von Nietlochrissen Vorschub leisten können*, C. Bach and R. Baumann. *Zeits. des Vereines deutscher Ingenieure*, vol. 56, no. 47, p. 1890, November 23, 1912. 6 pp., 14 figs. *cA*). The tests were made at the Laboratory for Testing Materials of the Technical High School at Stuttgart, Germany. Owing to lack of space only the final conclusions of this important investigation can be given here:

(*a*) The tests have shown that owing to the application of the usually large powers in *riveting machines* the sheets in the neighborhood of the riveting holes are subjected to stresses beyond the elastic limit. (*b*) With sheets adhering closely to each other, the pressure exerted by the riveting machine has no influence on the force with which the rivets after cooling hold the sheets together; the contraction in the shank of the rivet alone

is quite sufficient for the production of a large stress in the shank and a sufficient resistance to sliding in the rivet connection. The *magnitude of useful pressure required in riveting* appears therefore to be determined

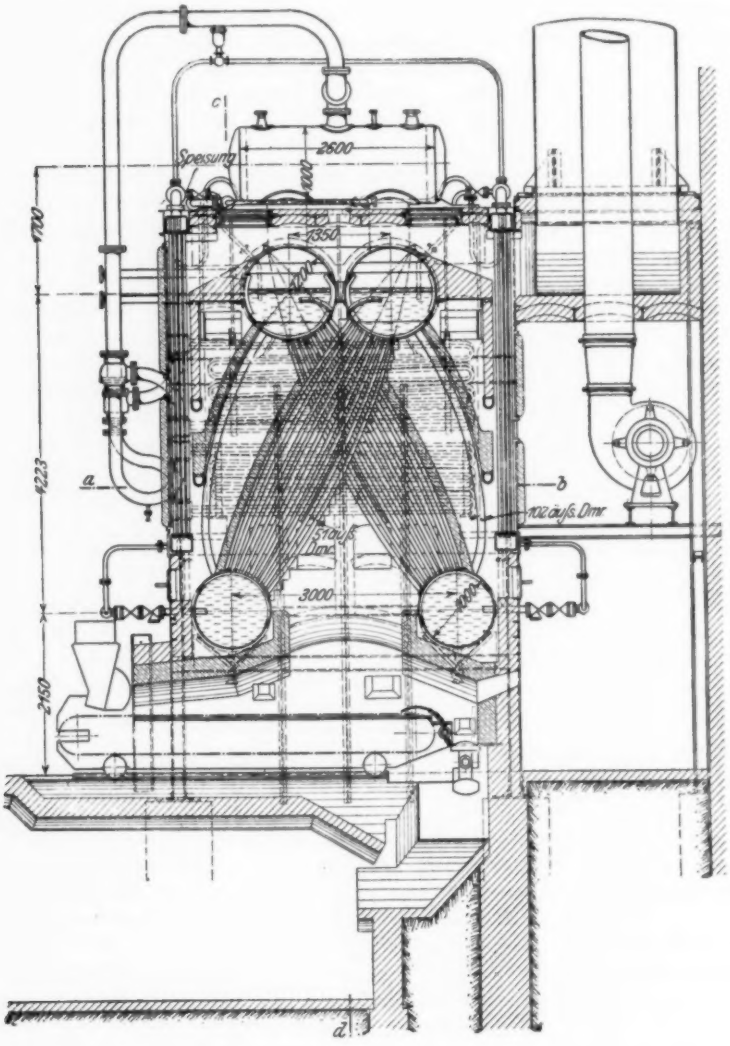

FIG. 6 BURKHARDT WATER TUBE BOILER

only by the following: (1) the necessity of making well formed, caulkable rivet heads, and (2) the necessity of keeping together sheets which would otherwise have a tendency to yawn. (*c*) When a larger pressure is applied than that warranted by (*a*), the sheets are stressed beyond the elastic

limit, and the riveted connection is actually made weaker than it would be with smaller pressure. The use of excessive forces in riveting explains the frequent occurrence of bending of sheets at the riveted joint and pressing-in of rivet heads in steam boilers which is due to crushing of the plate under the rivet head while riveting. (*d*) The length of time during which the riveting pressure is exerted is of importance only when the sheets have a tendency to spread, and even then the tests have shown that the application of a pressure during 1 minute is quite sufficient. (*e*) *Short rivets appear to be weaker than long ones*, a consequence of the change of shape in and under the rivet head. For lengths longer than $l = 3d$ no further increase in strength was found. The maximum observed stress approaches the lower elastic limit of the material. (*f*) When long rivets are partly warmed-up, there is a danger of the swage-heads breaking off and the material being permanently injured; this may be prevented by a fillet at the place where the shank connects with the rivet head. Several photographs of split rivet holes, rivets broken off at the swage-head, etc., are reproduced in the original article.

Experiments on the Distribution of Stresses in Punched Flat Bars (*Versuche über die Spannungsverteilung in gelochten Zugstäben*, E. Preuss. *Zeits. des Vereines deutscher Ingenieure*, vol. 56, no. 44, p. 1780, November 2, 1912. 3 pp., 6 figs. *e, and Mitteilungen über Forschungsarbeiten*, Heft 126, p. 47). The author made his tests with flat bars having a rectangular cross-section, and provided, across their middle axis, with a hole of diameter D (Fig. 7); the bars were subjected to a tension P along the longitudinal axis. Let the section of the remaining metal at A-C be called f. It is usual to design bars of this kind, as far as their safe strength is concerned, by determining the average stress $\frac{P}{f}$ in the section A-C, and then selecting P in such a manner that $\frac{P}{f}$ be well within the safe limits for the given material. It is here assumed, however, that the distribution of stresses in that cross-section is uniform throughout, and this is approximately true at the moment of rupture. But up to the elastic limit, or within the useful range of stresses, the stresses are not uniformly distributed: on the contrary, there is a considerably higher stress at the edges of the hole, and a much lower stress at the outer edges of the bar, approximately as shown by E-R in Fig. 7. The author shows also that: (*a*) the maximum stress at the edges of the hole is not materially affected by the magnitude of the diameter of the hole; (*b*) the maximum stress at the edge of the hole is 2.1 to 2.3 times greater than the value obtained for it on the supposition of uniform distribution of stresses through the section most weakened by the punching of the hole; (*c*) the minimum stress at the outer edge of the bar decreases as the diameter of the hole increases.

Investigation of the Direction of Stress in Inclined Plates (*Untersuchungen über die Kraftrichtung in schiefen Platten*, C. Busemann. *Zeits. des Vereines deutscher Ingenieure*, vol. 56, no. 47, p. 1907, November 23, 1912, 4 pp., 9 figs. *de*). Description and data of tests on the direction of

stresses in inclined plates. By inclined plates are here meant plates with bearings parallel to one another, but at an oblique angle to the longitudinal axis of the opening, so that in the horizontal projection the plate appears as shown in Fig. 8A. Textbooks as a rule state that the stresses are distributed on both sides of the line *A-B*, or equally on both bearings, but the author by several methods, mathematically and experimentally, shows that in the case of inclined plates with two bearings the resultant of stresses lies not in the middle between the bearings, but more towards the obtuse angles, as shown by the line *A'-B'*, in Fig. 8B. The methods for the determination of the position of the resultant are given, both for a single load in the middle and for a uniformly distributed load, and it is shown that if an inclined arch is subjected to an effort tending to shorten its arc, the resultant is shifted towards the obtuse angles, and towards the acute angles when the efforts tend to lengthen the arc. The first happens when the moment is positive (pressure above, tension below), the second when the moment is negative (tension above, pressure below), and may be due to changes of load, variations in temperature, etc. This article may be of particular interest to the designer of inclined reinforced concrete plates in showing how the reinforcing elements may be distributed to take care of the stresses arising in the various parts of the structure.

On an Experimental Method for Determining in Advance the Stresses which will arise in Structures (*Sur une méthode expérimentale pour déterminer à l'avance les tensions qui se produiront dans les constructions*, Mesnager. *Comptes Rendus des séances de l'Académie des Sciences*, vol. 155, no. 22, p. 1071, November 25, 1912. 2 pp. *cA*). If a sheet of glass is subjected to strains situated in its plane, and if at each of its points is projected, normal to its plane, a ray of polarized light, then: (*a*) it transmits two vibrations parallel to the principal stresses, thus permitting the determination of their direction; (*b*) the difference of the course of the two vibrations makes it possible to determine the difference between the two principal stresses, by the Werthein method; (*c*) the variation in thickness shows the sum of these stresses (for the general description of this method see A. Mesnager, *Utilization of the Accidental Double Refraction of Glass for the Study of Internal Stresses in Solids*, in Transactions of the Sixth Congress of the International Association for Testing Materials, XXVIII, 5, No. 11).

On the other hand it is known that elastic stresses in two dimensions depend on the differential equation

$$\Delta\ (n_x+n_y)=0,\ \Delta=\frac{\partial^2}{\partial_x{}^2}+\frac{\partial^2}{d\mu^2}$$

containing only coefficients of elasticity. Therefore, if the conditions at the limits do not depend on the coefficients of elasticity, the solution of the equation is entirely independent of them, and the distribution of stresses in the glass is fully identical with that in any other material. Hitherto this process has been applied only to the investigation of stresses in objects of simple shape, owing to the high cost and difficulty of making suitable complicated models and to the fact that in such models even careful annealing does not entirely remove the internal stresses produced in

making the piece; the same is true for composite pieces formed by welding.

The author has, however, obtained excellent results by gluing together pieces of glass cut from carefully annealed sheets using as an adhesive gelatine made soluble at room temperature. It is quite transparent and does not hinder observation, giving at the same time, when dry, a tangential adherence of 0.5 kg/qmm (711 lb. per sq. in.) which is sufficient for all general purposes. The model is constructed while in a horizontal position, and is left so until completely dry: in this way internal stresses are nearly entirely eliminated.

The author has investigated by this method a project of a bridge 97 m (320 ft.) span by making a model 0.003 to 1, and by reducing the section to rectangles by means of appropriate formulae of mechanical similarity, and succeeded in determining: (*a*) the points of maximum stresses; (*b*) the most unfavorable combinations of loads; (*c*) the magnitude of maxi-

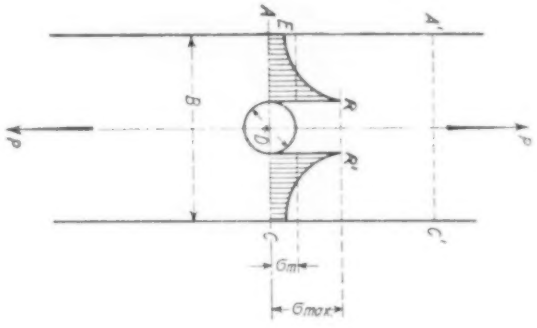

FIG. 7 DISTRIBUTION OF STRESSES IN PUNCHED FLAT BARS

mum stresses, tensile and compressive. Check values obtained by the additions of the stresses produced by the action of separate loads on one hand, and by the direct application of the most unfavorable total load, differed by less than 1 per cent from the values of the maximum tensile or compressive stresses. The cost of the model amounted to less than 1/10 of 1 per cent of the work. Cp. also *Engineering Record*, no. 2, 1913, January 11, p. 30, *Optical Determination of Stresses*, where similar experiments with models made of celluloid compounds are described.

HYDRAULIC LIME (*Hydraulischer Kalk*, G. Hentschel. *Tonindustrie-Zeitung*, vol. 36, no. 139, p. 1843, November 23, 1912. 1 p. *pt*). The usual equation for the determination of the *hydraulic modulus* of hydraulic lime is $\frac{CaO + MgO}{SiO_2 + R_2O_3}$, but this equation gives only the theoretical modulus, and does not take account of the free silicic acid, clay and unburned calcium carbonate which affect the properties of hydraulic lime. Table 2 column I gives the actual figures as obtained by analysis, II is the chemical composition of the same material burned and free from water and carbon dioxide, III is the corrected analysis taking care of the loss in burning, while IV

is the same as III, but reduced to water-free material. It is seen from these analyses that while the theoretical hydraulic modulus is

$$M_t = \frac{CaO + MgO}{SiO_2 + R_2O_3} = \frac{75.51}{24.13} = 3.13$$

the actual hydraulic modulus is

$$M = \frac{58.13}{15.77} = 3.68,$$

an important difference considering the value of hydraulic lime is the higher the nearer its hydraulic modulus approaches that of portland cement. The author recommends therefore that not only the theoretical modulus be indicated, but the actual modulus and percentage of non-mortar materials as well (insoluble matter and calcium carbonate).

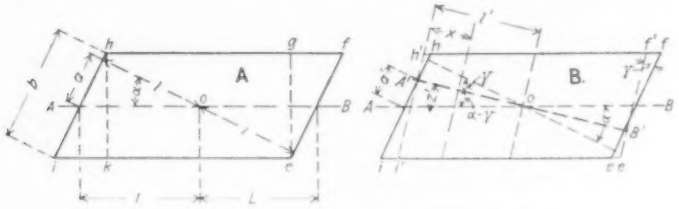

FIG. 8 DIRECTION OF STRESS IN INCLINED PLATES

TABLE 2 PERCENTAGE ANALYSES OF HYDRAULIC LIME

	I.	II.	III.	IV.
SiO_2	14.0	16.89	8.30	9.15
Al_2O_3	6.0	7.24	6.00	6.62
Fe_2O_3				
CaO	62.1	74.91	52.20	57.58
MgO	0.5	0.60	0.50	0.55
SO_3	0.2	0.24	0.20	0.22
Loss in burning	17.1	...	...	...
Not determined	0.1	0.12	0.10	0.11
$CaCO_3$	...	...	17.66	19.48
Insoluble matter	...	...	5.70	6.29
Water	...	...	9.34	...

The author made experiments with addition of gypsum to hydraulic lime and found that it affects favorably the tensile and compressive strength of lime, and does not involve any particular difficulties as it does not affect the setting time of lime.

CHRISTIANIA LABORATORY FOR TESTING MATERIALS (*Kristiania MaterialprΦvcanstalt, Teknisk Ukeblad*, vol. 59, no. 51, p. 653, December 20, 1912. 4 pp., 5 figs. *d*). Description of the recently opened laboratory for testing materials in Christiania, Norway (Director Engineer Wazau).

ON SELF-STRESSES AND DERANGEMENTS IN MACHINE PARTS THEREBY PRODUCED (*Über Eigenspannungen, insbesondere Reckspannungen, und die dadurch bedingten Krankheitserscheinungen in Konstruktionsteilen. Zeits. für präktischen Maschinenbau*, vol. 3, no. 48, p. 1618, November 27, 1912. *ctA*). Account of a paper presented by Prof. E. Heyn, of the Royal Laboratory for Testing Materials of Gross Lichterfelde West, at the 14th annual

meeting of the German Society of Naval Construction, in which he traced the cause of some hitherto unexplained breakdowns of steam turbine blades and other machine parts to what he calls *self-stresses* (*Eigenspannungen*); such stresses arise when in a machine element certain parts rigidly connected together are submitted to different stresses and have, owing to the rigidity of connection, to equalize them by elastic changes of form. Such stresses may arise both through unequal heating and cooling, or by permanent changes of shape at ordinary temperature, such as cold rolling, cold hammering, etc. Professor Heyn has worked out a process for determining the magnitude of such stresses, and a series of tests have been made at the Royal Testing Laboratory, at Gross Lichterfelde West which have given an insight into the nature of these stresses; finally means have been devised for obviating their appearance in metal parts when subjected to cold working. He showed further that there is a large number of undesirable structural modifications in metals which apparently have no connection with one another, but can in the final analysis be traced to self-stresses; to this group belong ruptures of steam turbine blades made of high percentage nickel steel, fractures in rods, wires, plates and tubes made of brass, bronze, aluminum bronze, etc.; breakdowns of the above parts, owing to temperature variations and mechanical injuries, as well as to the action of certain paints, and influence of working at a blue heat (150 to 350 deg. cent., or 302 to 662 deg. fahr.) on iron, etc.

A more complete account of this paper will be given in The Journal when the full text of the original paper is received in this country.

Thermodynamics

THE MODERN DEVELOPMENT OF THERMODYNAMICS (*Zur neueren Entwicklung der Thermodynamik*, H. Sieveking. *Journal für Gasbeleuchtung*, vol. 55, no. 48, p. 1174, November 30, 1912. 3 pp. *t*). A discussion of the latest achievements of thermodynamics, mainly on the basis of a paper read by Professor Nernst before the Munster meeting of the German Scientists and Physicians. The two most important things that were unknown to the founders of the science of thermodynamics are radioactivity and the measurement of energy contents or specific heats of substances. The author, or rather Professor Nernst, holds that in accordance with the second law of thermodynamics the amount of that energy in the world which is convertible into work is becoming more and more dissipated (Cp. Chas. P. Steinmetz, The Second Law of Thermodynamics and the "Death" of Energy, General Electric Review, July 1912, vol. 15, no. 7, p. 419) since, as soon as heat has flown to a lower temperature level, its convertibility into work is no more possible; in addition, the matter itself is being "degraded" owing to the action of radioactive forces, gradually changing nobler metals into baser. The only way in which these tendencies may be counteracted is by some reconstruction process of the elements themselves, but it does not appear that such processes do actually take place, at least not within the limits of time accessible for experimentation and observation.

A brief discussion of the Planck theory of quanta, and some of the developments based on it, follows, as well as brief statements of the work of Haber and Just on the relation between the reaction heat of the chemical

processes and the electronic frequency as determined by the selective photo-electric effect. The bearing of the Einstein formula on the law of Dulong and Petit is also discussed. The article is of considerable interest in that it gives the latest data on the development of the theory of thermodynamics with only a very sparing use of mathematical formulæ or terms.

RELATION BETWEEN THEORY AND EXPERIENCE IN THE DOCTRINE OF HEAT TRANSMISSION (*Beziehungen zwischen Theorie und Erfahrung in der Lehre vom Wärmeübergang*, H. Gröber. *Gesundheits-Ingenieur*, vol. 35, no. 50, p. 929, December 14, 1912. 7 pp, 2 figs. *mtA*). Mathematical investigation of the theory of heat transmission, mainly as applied to the case of fluids flowing through pipes. The author applies the so-called *principle of similarity*. The essential elements of this method consists in the following: a comparison is made between two or more systems (e.g. flow with local temperature inequality) similar to one another in a certain particular. This similarity is mathematically established by the requirement that the respective processes in both systems should satisfy the same differential equations, the latter therefore to be solved in the same manner. The processes within each group of the similar systems occur then in the same way, and the number of independent variables to be established experimentally in determining the functional relations is correspondingly reduced. The author proceeds to show how the *similarity characteristic* is determined, and how this method is applied to the investigation of the problem of heat transmission in the case of fluids flowing through pipes. He derives a general formula for the coefficient of heat transmission in the case of flow through pipes, but points out the following deficiencies in the methods of treating this problem: (*a*) lack of knowledge as to the laws governing the relation between the coefficient of heat transmission and the length of the pipe in the case of turbulent flow (flow accompanied by the production of eddies); (*b*) lack of uniformity in the determination of relative roughness of pipes; (*c*) lack of exact data as to the viscosity and heat conductivity of gases and especially of liquids, as well as their variation with temperature. The article treats the principle of similarity in comparatively easy mathematical methods (only very simple partial differentials are used) and in a very clear style. A short bibliography is appended.

Miscellanea

TRACTORS: AVERAGE AND MAXIMUM TRACTIVE CAPACITY (*Tracteurs agricoles: traction moyenne et traction maximum*, Max Ringelmann. *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, vol. 118, no. 3, p. 448, November 1912. 7 pp., 7 figs. *e*). The author claims that many failures of farm tractors were due to designers often equipping them with power sufficient only to provide *average* efforts at the drawbar. He made a series of tests with nine tractors of French design, and found that, on various grounds, the maximum effort T varied from $110.55t$ to $154.70t$, where $100t$ was the average effort, and the stretch over which this maximum effort was exerted varied from 2 to 27 per cent of the total run of the tractor. The author recommends therefore that the engine be proportioned so that it could deliver when called upon, an effort

$$T = 175\,t$$

The weight of the tractor must be such that there should be adherence enough between the ground and the driving wheels of the machine to prevent slipping at the maximum driving resistance. Tabular data and diagrams of efforts are given in the original article.

CONSTITUENT GENERAL MEETING OF THE SOCIETY "TECHNICAL MUSEUM OF INDUSTRIES AND TRADES IN VIENNA" (*Konstituierende Generalversammlung des Vereines "Technisches Museum für Industrie und Gewerbe in Wien." Zeits. des Oesterreichschen Ingenieur und Architekten-Vereines*, vol. 64, no. 49, p. 777, December 6, 1912. 1 p. *g.*). Reportorial account of the first meeting of the Society for the Establishment of a Technical Museum of Industries and Trades in Vienna. No details as to the program and scope of the Museum are given. For the latter see *Scientific American*, January 11, 1913.

Supplementary References

BENDING OF CAST IRON BARS (Foreign Review, June 1912 p. 971). The full text of the original investigation published in *Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens*, Heft 127 and 128, 101 pp., 55 figs.

EXPERIMENTS ON REDUCTION OF STRESS BY ROUNDING OFF SHARP ANGLES (Foreign Review, November 1912, p. 1897). The full text of the original investigation published in *Mitteilungen über Forschungsarbeiten*, Heft 126, 24 pp., 27 figs.

DISTRIBUTION OF STRAIN IN CRANE HOOKS (Foreign Review, March 1912, p. 409). The full text of the original investigation published in *Mitteilungen über Forschungsarbeiten*, Heft 126, 22 pp. 27 figs. The investigation is interesting in that it shows the unreliability of theoretical calculation of stresses in crane hooks, stresses so determined being sometimes greater, at other times considerably smaller than those actually occurring.

SCHOOP PROCESS OF GALVANIZING (Foreign Review, March 1912, p. 418). Description of the process as it is now used and improved apparatus in *Zeitschrift für Sauerstoff- und Stickstoff*, vol. 4, no. 12, p. 245, December 1912.

ARTICLES UPON GAS POWER

(Prepared by the Literature Committee)[1]

DIESEL ENGINE USERS, SOME PRACTICAL CONSIDERATIONS FOR. *The Engineer* (London), December 6, 1912. 2 columns. *pA*.

Its suitability for many kinds of crafts, etc.

MOTOR CAR SHOW AT OLYMPIA. II. *The Engineer* (London), November 15, 1912. 2 pp., 7 figs. *dpC*.

Description of various motors for cars.

MOTOR SHIP JUNO, THE. *The Engineer* (London), November 15, 1912. 3 figs. *C*.

Description of ship and engines.

MOTOR VEHICLES, THE DESIGN OF, H. E. Wimperis. *The Engineer* (London), November 15, 1912. 2 pp., 3 figs. *dmpA*.

Size of engines and gear ratios, break m.e.p. independent of stroke and bore, tractive effort and complete design of motor.

PEAT FUEL IN GAS PRODUCERS AND THE ELIMINATION OF TAR FROM PRODUCER GAS, CANADIAN STUDIES OF, B. F. Haanel. *Engineering News*, December 5, 1912. 8 figs., 3 tables.

PETROLEUM AS A SOURCE OF POWER FOR SHIPS, Albert Sommer. *The Journal American Society of Naval Engineers*, November 1912. 27 pp., 7 tables.

PRODUCER GAS IN SOUTH STAFFORDSHIRE, THE GENERATION AND DISTRIBUTION OF, H. A. Humphrey.

Extract of paper read at meeting of Institution of Civil Engineers, December 10, 1912.

MOTOR SHIP ROLANDSECK. *The Engineer* (London), December 15, 1912. 1 column and supplement, 4 figs. *dpB*.

Description of the Carels-Tecklenborg engines.

SMITHFIELD CLUB SHOW, THE. *The Engineer* (London), December 19, 1912. 3 pp., 5 figs. *C*.

Description of Peter's semi-Diesel engine; Davy Paxman's gas engine; Ruston Proctor's oil engine, etc.

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[1] Opinions expressed are those of the reviewer, not of the Society. Articles are classified as *c* comparative; *d* descriptive; *e* experimental; *h* historical; *m* mathematical; *p* practical. A rating is occasionally given by the reviewer, as *A*, *B*, *C*. The first installment was given in The Journal for May 1910.

REPORTS OF MEETINGS

MEETINGS IN CHICAGO

At a meeting of the Chicago Section in that city on November 21, 1912, P. M. Chamberlain, Chairman of the Committee on Meetings in Chicago presided. The affairs of the Section were turned over to the new committee by the retiring chairman, George M. Brill. Addresses were made on behalf of the Society by W. F. M. Goss, for the Western Society of Engineers by W. L. Abbott, for the American Institute of Mining Engineers by Capt. Robert W. Hunt, and for the American Institute of Electrical Engineers by Peter Junkersfield. P. W. Gates also spoke. This meeting was held at the Chicago Engineers Club, with about 60 in attendance.

On December 19, 1912, a meeting was held in the rooms of the Western Society of Engineers, with Engineering in Panama and South America as the subject of the evening, Col. Henry A. Allen speaking upon the Association of Commerce, upon the achievements in South America. An work in Panama and F. C. Enright, South American representative of the informal discussion followed. About 60 engineers attended this meeting.

ST. LOUIS MEETING, DECEMBER 14

The Local Section of the Society in St. Louis held its annual meeting on December 14, at the Mercantile Club, the meeting being preceded by an informal dinner. The following members were elected to serve on the local committee: E. H. Ohle (five years), F. E. Bausch (four years), John Hunter (three years), L. C. Nordmeyer (two years), and F. N. Jewett (one year), Professor Ohle serving as chairman, and Mr. Bausch as secretary.

A general discussion followed on engineering subjects of present-day interest. The local committee, together with J. H. Boughton, was requested to draft a report on the desirability and benefits of installing water meters for all consumers of city water.

NEW YORK MEETING, JANUARY 14

At this first meeting of the year, the plan adopted last year was followed of discussing matters identified with the work of the New York Committee. Following this discussion, a brief paper was presented by F. A. Waldron on Factors of Scientific Management other than Labor Problems. This paper is in substance the discussion offered by Mr. Waldron upon the report of the sub-committee on Administration, given at the Annual Meeting, and will be referred to more at length in a later issue.

For the purpose of keeping the New York membership in touch with what the local committee has done, a communication from the retiring

chairman, Fred. H. Colvin was read, summarizing the meetings for the past year, and outlining his views upon the question of ways and means for providing for the entertainment at the time of the Annual Meeting, already much-discussed. In accordance with a vote of the committee a year ago, the recent Annual Meeting had been conducted on the "pay as you go" plan. The circular announcing this plan was sent to the membership along with several other circulars on different subects, and undoubtedly was overlooked by many members who came to the meeting without a knowledge of the new plans. He advocated another trial of the plan to form a fairer basis of comparison with the previous system of soliciting subscriptions locally.

Following this, the discussion was opened, upon request of the chairman, by R. V. Wright for the "pay as you go" plan and by Edward Van Winkle for the subscription plan. Mr. Wright said that the canvass of the New York membership last year showed the sentiment to be in favor of a $3 annual assessment on the New York members, but this had not been approved by the Council and the committee therefore made a trial of having every member pay for such entertainment as he participated in, with the exception of the President's Reception, which was paid for out of the Society funds. This was in line with what many other societies are doing, notably the Master Car Builders Association and the American Railway Master Mechanics Association. There are many young men in the New York membership who want to enjoy the privileges of the Society but cannot afford the usual contribution heretofore called for, and they are likely to remain away from professional as well as social meetings on this account.

Mr. Van Winkle confined his remarks mainly to attendance figures at the Annual Meetings of the past three years, showing an increase in 1911 over 1910, but a decrease in 1912, although there had been a large increase in membership. At the luncheons those participating in 1912 were fewer in number also and at the second day of the luncheon there was a marked decrease. The main object of luncheons is to promote sociability and to keep the members together so as to increase the attendance at professional sessions. Failing in that, why not abandon Society luncheons? Under the subscription plan while the payments came on the average from only about one-third of the local membership, it was not the same 300 who contributed every year. The average was $10 per subscriber, but amounts as small as $1 were received and there were many cases where it was arranged that members should receive tickets to the Thursday night reunion even though they did not contribute the actual value of the ticket. The subscription plan is necessary to create an air of hospitality.

Messrs. Wright and H. R. Cobleigh contended that the figures quoted had no significance, and the decrease in attendance at the second day's luncheon last December was attributed to disatisfaction with the service. Simultaneous sessions were held throughout the convention, making it difficult to attend the luncheons in some cases. At the Railroad Session were many who came for that meeting only and undoubtedly did not register; and they were unable to attend the luncheon as the interest in the meeting was so great that it did not adjourn until 1.30.

Fred. J. Miller had for a long time advocated an increase in the dues of local members. The expense to them would be no greater than that of an out-of-town member who came only occasionally to a convention and had transportation and hotel expenses to pay. However, the "pay as you go" plan had its advantages. He believed that most of the falling off at luncheons was due to the New York members taking lunch elsewhere, as he had met mainly out-of-town people during the lunch hour in the Engineering Societies Building.

Several outlined the successful and apparently unobjectionable means that had been adopted in other cities for the Spring Meetings for the entertainment of guests. Jesse M. Smith who formerly lived in Detroit said that when there were only twenty members in that city not only was there no difficulty experienced in raising funds for the entertainment of the Society but that it was a pleasure to do this and that $200 above the expenses was turned over to the library of the Society. William Kent was reminded of the trip to Europe in 1889 when free transportation was provided between Liverpool, London and Paris, and so large a sum was raised that a dividend was returned to subscribers. This experience was repeated in a measure in this country when the British Iron & Steel Institute and the Verein deutscher Ingenieure came here. Reference was made also to the Richmond meeting which was so successful, where the experience had been similar to that of Detroit; and by another member to a more recent meeting where it was believed that the subscription plan had been found burdensome although the members locally were not disposed to admit that such was the case.

This led to the question of approaching manufacturers for subscriptions, which while generally practised in the smaller cities, was not attempted in New York and it was believed would be considered unprofessional to do so under the conditions which here exist.

Various other speakers expressed their preference for or against the "pay as you go" plan, and Mr. Cobleigh emphasized that members in out-of-town places would not feel that they could take the initiative in introducing the "pay as you go" system, even though they might find subscriptions burdensome, until New York had introduced this as a policy for the conduct of the Annual Meetings.

The attendance at this meeting was small, but as a test of the sentiment of those present, a rising vote was taken, showing 33 in favor of reverting to the subscription method, and 17 in favor of the "pay as you go" plan.

BOSTON MEETING, JANUARY 22

The members of the Society and the Boston Section of the American Institute of Electrical Engineers joined the Boston Society of Civil Engineers at a meeting held in Chipman Hall on January 22, 1913. William H. Lewis, president of the Lewis Wiley Hydraulic Company of Seattle, Washington and Portland, Oregon, gave a talk on Hydraulics in City Building, copiously illustrated with lantern slides. Mr. Lewis described the work done by his Company at Denny Hill and Jackson Street Hill, Seattle, where the prevailing grades of 15 to 20 per cent were reduced to from 3 to 5 per

cent and the material taken out used to fill tide lands on the water front constituting the terminals of the Great Northern, Northern Pacific and Union Pacific Roads. The slides showed very clearly the manner in which the material was taken out by hydraulic "Giants" conveyed by sluices and pipe lines to the fills and in many cases buildings and streets were raised and supported on temporary trestles while filling was done under them. He also explained how the blue clay which in a bank would resist the action of a hydraulic jet almost indefinitely, was loosened by shooting it with dynamite at the bottom of the bank so that a matter of a few hours sufficed to crumble it into a consistency that could be floated away. Later on he described the work of his Company at Portland, Oregon, where the matter handled was predominantly gravel. A very interesting detail was the method of applying the renewable linings to the bottom of the sluices and pipes. The character and extent of the pumping plant which comprised electrically driven centrifugal pumps of great capacity was strikingly shown.

In the discussion some very interesting points were brought out by the large number of questions which were asked during and at the close of the talk.

STUDENT BRANCH MEETINGS

ARMOUR INSTITUTE OF TECHNOLOGY

On January 15, 1913, the Armour Institute of Technology Student Branch was addressed by C. W. Taylor, who spoke on the Power Plant of Marshall Field & Company. The lecture was of particular value because of the speaker's personal experience at the plant in the capacity of operating engineer. A general discussion followed in which Professor Gebhardt, O. Schmeiman, M. D. Wold, E. R. Burley and H. R. Kuehn took part.

COLUMBIA UNIVERSITY

At a meeting of the Columbia University Student Branch on January 9, 1913, two papers were presented, Gas Engine Design, by M. H. C. Brombacher, and Furnaces and their Construction, by Mr. Rittman.

LEHIGH UNIVERSITY

A meeting of the Mechanical Engineering Society of Lehigh University was held January 14, at which Mr. Rosenschweig of the Erie City Iron Works spoke on The Application of the Lentz System of Superheat to Different Types of Prime Movers. The lecture was illustrated with lantern slides showing the application of the Lentz system to stationary marine and locomotive engines, the construction and manner of operation of the poppet valves and the governing apparatus. Statistics were given showing the efficiency and economy of the Lentz system.

LELAND STANFORD JUNIOR UNIVERSITY

The Student Branch at Leland Stanford Junior University has been active during the past semester. On October 8, Prof. W. F. Durand gave an address on the Diesel Engine and its Growing Importance Commercially, and at a meeting held on October 22 papers were presented by C. S. Simon on Alloy Steel, and by K. I. Marshall, on High-Speed Steel. On November 25, Prof. Guido H. Marx gave an illustrated talk explaining his experimental derivation of new constants for the Lewis gear formula.

It is expected to have a number of scheduled addresses during the Spring semester.

POLYTECHNIC INSTITUTE OF BROOKLYN

At a meeting on January 4, Mr. S. Rosenzweig of the Erie City Iron Works lectured on the Lentz Engine, with discussion by Prof. W. D. Ennis, Prof. A. A. Adler, and Messrs. Greer, Heustis and Kessler, and many of the members.

STEVENS INSTITUTE

The Stevens Engineering Society held a meeting on January 7 at which Calvert Townley, assistant to the President, Westinghouse Electric and Manufacturing Company, spoke on the Electrification of the New York, New Haven and Hartford Railroad, the largest examples of steam railroad electrification in the world. Prof. A. F. Ganz and J. H. Vander Veer discussed the subject at the conclusion of the address.

R. V. Norris, Mem.Am.Soc.M.E., consulting engineer for the coal companies of the P.R.R. Co., D.L.&W.R.R. Co., the Wilkes-Barre and Hazelton R.R. Co., and the Sterling Salt Co., and who is a lecturer on Coal Mining at Harvard University, gave an address on Mechanical Preparation of Anthracite, on January 21. On February 11, Rudolph Hering, Mem.Am. Soc.M.E., will speak on Sewage Disposal, on which he is an authority.

SYRACUSE UNIVERSITY

At a meeting of the Syracuse University branch on December 12, S. Rosenzweig of the Erie City Iron Works delivered an instructive talk on the Lentz Engine, illustrated by lantern slides. On December 19, Prof. John E. Sweet, Hon.Mem.Am.Soc.M.E., gave a brief history of the steam engine, in which were included some interesting personal reminiscences.

UNIVERSITY OF ILLINOIS

The University of Illinois Student Branch held its regular meeting on January 17, electing the following officers for the semester: C. A. Schoessel, president, A. M. Simpson, vice-president, E. M. McCormick, secretary, and Geo. M. Meyer, treasurer. A talk on The Properties of Saturated and Superheated Ammonia was given by W. E. Mosher.

UNIVERSITY OF MISSOURI

On January 6 J. W. Haney and R. Runge presented a paper on Agricultural Machinery, illustrated by lantern views of farm scenes and implements used.

UNIVERSITY OF NEBRASKA

At a meeting on January 7, the Uses of the Tractor was presented by E. R. Wiggins and discussed by Prof. L. W. Chase and Prof. J. D. Hoffman.

YALE UNIVERSITY

An illustrated lecture on the Use of Superheated Steam and the Lentz Engine was delivered by S. Rosenzweig of the Erie City Iron Works, at the meeting of the Yale Mechanical Engineers Club, on January 7. A general discussion followed.

NECROLOGY

ELMER S. FARWELL

Elmer S. Farwell who died in Kansas City, Mo., on December 13, 1912, was born December 20, 1863, at Morrison, Ill. He received his education at the Baldwin University, Baldwin, Kan., and later at the Rensselaer Polytechnic Institute, Troy, N. Y., being graduated in the class of 1891. For a time he was in the employ of the Illinois Steel Company at South Chicago, going from there to the Patent Office at Washington, where he was assistant examiner in the Division of Steam Engineering. During this period he was also an instructor in the department of steam engineering of Columbian University, Washington, D. C. In 1898 he came to New York to take up work with the International Paper Company, but later retired from their employ to open an office for himself as consulting engineer. In this capacity he was retained by the Yellow Pine Paper Mill Company to install their evaporator system and later to rebuild their plant. In the fall of 1911 he moved to Kansas City, where he continued his consulting practice until shortly before his death.

ERWIN GRAVES

Erwin Graves was born near Tiffin, Ohio, August 19, 1850, and was educated in the public schools. At the outset of his career he was for several years surveyor for railroads. He then entered the employ of J. D. Cook of Toledo, Ohio, where he assisted in the building of the Sandusky Water Works. During his four years' residence in Sandusky he was superintendent of water works and city engineer. From Sandusky Mr. Graves went to Quincy, Ill., where he built the water works, later going to Atlantic City, N. J., in the employ of R. D. Wood & Company, for the same purpose. In 1885 he became connected with the Camden Iron Works, Camden, N. J., and was until 1890 assistant superintendent. In 1894 he returned to the works as superintendent, a position which he held at the time of his death on December 13, 1912.

Mr. Graves was a member of the Engineers Club of Philadelphia for many years, but resigned from it before his death.

HARRY M. ROSE

Harry M. Rose was born at Albany, N. Y., November 22, 1856, and died at Elizabeth, N. J., December 25, 1912. He received his education in private schools and under private tutors, and afterwards entered the service of the F. O. Matthiessen and Wiechers Sugar Refinery, with a view to learning the business. Upon completion of a four years' course he went to San Domingo and there engaged in sugar harvest work. Following this he went to the Philippine Islands for the George L. Squier Manufacturing Company of Buffalo, N. Y., and was engaged in that country for a period of three years in installing the machinery on sugar and rice plantations. Upon his return from the Philippines he made a number of trips to Mexico and Central America as constructing and consulting engineer in the line of plantation machinery.

EMPLOYMENT BULLETIN

The Society considers it a special obligation and pleasant duty to be the medium of securing better positions for its members. The Secretary gives this his personal attention and is pleased to receive requests both for positions and for men. Notices are not repeated except upon special request. Names and records, however, are kept on the current office list three months, and if desired must be renewed at the end of such period. Copy for the Bulletin must be in hand before the 12th of the month. The list of "men available" is made up from members of the Society and good men not members. Information will be sent upon application.

POSITIONS AVAILABLE

018 Assistant to manager of factory, preferably technical graduate with engineering training, but of prime importance that applicant have actual experience in directing production of merchandise. Location, Connecticut.

019 Technical graduate with three to five years' experience in electrical or gas apparatus testing work, for development and acceptance tests with installation work of new line of high grade apparatus. The right man will have an opportunity for valuable experience and opportunity for advancement to a responsible position in a growing manufacturing and selling organization in the Middle West.

020 Young engineer for metallurgical plant, technical education with several years' mechanical engineering experience and possessing fair working knowledge of chemistry and electrical engineering; to take care of plant engineering work, conduct miscellaneous investigations and institute improvements; should be resourceful and energetic. Location, Middle West.

021 A new steam turbine of the compound impulse, multi-stage type, capable of good efficiency in all sizes from 1 h.p. upward, is ready for commercial development. A high-grade successful salesman of steam turbines, who can furnish necessary capital, is desired as a partner to assist in development of the project. Reply through the Society.

022 Young engineer for time and operation study and to start in on efficiency work under superintendent. Location, Connecticut.

023 Mechanical draftsman with one to two years' experience for tracing and detail work. Salary according to experience. Location, New York.

024 Man with experience in steam work, particularly along power lines, and if possible familiar with heating and ventilating work, who would be interested in partnership with firm of consulting engineers in Boston. Particularly desire man of good address who would be willing and able to spend the larger portion of time looking after and supervising new work in field, or office. Apply through the Society.

025 Mechanical draftsman on mill work, position will pay from $25 to $30 a week. Location, within 100 miles of New York. Apply through the Society.

026 Assistant to sales manager in steam turbine business. Location, New England. Technical graduate with two or three years' experience preferred, with some executive ability. Good opportunity. Immediate answer necessary.

027 Mechanical draftsman on building and installation of street railway equipment, car barns, etc. Salary $100 to $150 a month. Location, New York.

028 Two draftsmen with experience in designing four-cylinder, four-cycle gasolene engines of sizes from 5 to 11 in. bore. Salary $150 a month. Location, Middle West.

029 Recent college graduate to take charge of machinery in small mill; if capable the applicant later to become superintendent. Location, New Jersey.

030 Man with executive ability to take charge of the engineering of a large plant; should have experience in machine design, power plants, and building construction. Applicants in answering this notice should state age, education, experience, and salary expected; give references. Norton Company, Worcester, Mass.

031 Chief draftsman, with executive ability, experience in up-to-date manufacture of interchangeable parts, resourceful in design. Location, New Jersey.

MEN AVAILABLE

22 Mechanical engineer desires position as superintendent or works engineer. Experienced executive with broad technical, commercial and practical training. Will show results accomplished in present and previous connection.

23 Member, technical education, extended experience as machinist, chief draftsman and engineer on power transmission, cement, industrial, illuminating gas and power plants, heating and ventilating installations, conveyors, estimating, appraisals and management of public service properties, at present employed but desires position with consulting engineer or public utilities corporation.

24 Position desired as assistant to purchasing agent or executive, taking care of specifications, contracts, development and research work; general mechanical, electrical, experimental and works engineering experience.

25 Associate, age 34, desires position as superintendent or works engineer: construction, railway and factory engineering experience.

26 Member desires to become identified with firm of consulting engineers, or as sales engineer for manufacturing organization. Age 35, Mass. Inst. Tech. graduate, 15 years' experience in design, erecting, testing, and experimental work, including four years' on government staff, steam engineering testing laboratory; now in charge of engineering work in post-graduate department of a leading eastern educational institution.

27 Member, age 35, 15 years' experience in operating and designing power plants, machine, car and railroad shops; good organizer and manager; desires position as mechanical and electrical superintendent with some good concern or chief engineer of a group of power plants. Would consider traveling position. Highest grade of references.

28 Member, technical graduate with 20 years' experience in the design and construction of road-making machinery, engines, boilers, motor trucks, etc. Works manager 3 years; chief engineer, 8 years. Design problems, factory accounting, cost reduction.

29 Member, age 46, experienced designer of all kinds of engines and apparatus relating to power, refrigeration and marine engineering, expert on fuel oil engines.

30 Member desires position as works manager, preferably wtih new company just starting business; long experience as factory man and engineer; at present head of engineering department of large company.

31 Sales engineer, technical graduate with wide experience, has opened New York office and can take hold of another good account on commission or part commission; will give personal attention until product is well on market.

32 Member, broad general experience along mechanical and electrical lines in both engineering and executive positions, desires connection with consulting or contracting engineers, manufacturing company or sales agency in or near New York City.

33 Member, experienced as salesman, manager, superintendent of manufacturing plant, power house work, either design or construction, desires position in New York.

34 Trained manufacturing executive experienced in problems of management, efficiency, factory and commercial accounting, general office management; technical graduate, desires position in New York State or New England territory.

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ACCESSIONS TO THE LIBRARY

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This list includes only accessions to the library of this Society. Lists of accessions to the libraries of the A. I. E. E. and A. I. M. E. can be secured on request from Calvin W. Rice, Secretary, Am. Soc. M. E.

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COCOA AND CHOCOLATE, THEIR CHEMISTRY AND MANUFACTURE, by R. Whymper. *London, 1912.*

CÓDIGO CIVIL DE LA REPUBLICA ORIENTAL DEL URUGUAY. Edición Oficial. Montevideo, 1893. Gift of Uruguay Republic de Oriental.

DRAFTING OF CAMS, Louis Rouillion, ed. 3, no. 2. *New York, 1908.*

ELECTRIC CRANES: THEIR DESIGN, CONSTRUCTION AND APPLICATION, H. H. Broughton, *London, 1911.*

ELECTRIC POWER FROM THE MISSISSIPPI RIVER. Bull. no. 8, December, 1912. *Keokuk, 1912.* Gift of Mississippi River Power Co.

L'ELECTRIFICATION DES GRANDES LIGNES DE CHEMINS DE FER, C. O. Mailloux. *Torino, 1912.* Gift of author.

ELEMENTS OF HEATING AND VENTILATION. A textbook for students, engineers and architects, Arthur M. Greene, Jr. *New York, J. Wiley & Sons, 1913.*

The author is a member of the faculty of Rensselaer Polytechnic. The book is clearly written, with a very logical arrangement. There is a chapter on district heating and one on temperature control. A large amount of necessary data has been incorporated.

ELEMENTS OF MACHINE DESIGN. Part 2, W. C. Unwin and A. L. Mellanby. *London, Longmans, Green & Co., 1912.* Gift of W. C. Unwin.

The volume deals almost exclusively with steam engine details. The present edition has been largely rewritten from experience gained by the use of the former edition in the Royal Technical College, Glasgow. New chapters on governors and condensers have been added.

ENGINEERING AS A VOCATION, Ernest McCullough. *New York, D. Williams Co., 1911,*

Beginning with a short history of the engineering profession and giving the

definition of an engineer as given by various authorities, the author proceeds to take up engineering as a vocation, describing the education of the engineer, the value of a technical education, and discusses fully the commercial side of the engineer's profession. For instance, one of the titles of his chapters is How to Hunt and Hold a Job. It would seem that all engineers might read this book with great interest and that its perusal would broaden their point of view.

ENGINEERING OF SHOPS AND FACTORIES, H. G. Tyrrell. *New York, 1912.*

ENGINEERING RECORD, vols. 17, 18. *New York, 1887-1888.*

DIE ENTSTEHUNG DES DIESELMOTORS, R. Diesel. Schiffbautechnische Gesellschaft, 1912. Gift of R. Diesel.

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ÉTUDE SUR LES LOCOMOTIVES DE MONTAGNE ET PARTICULIEREMENT LA LOCOMOTIVE COMPOUND ARTICULÉE SYSTÉME MALLET. M. A. Mallet. *Paris, 1912.* Gift of author.

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LEHRBUCH DER TECHNISCHEN PHYSIK, Paul Müller. *Berlin, 1912.*

THE LOCOMOTIVE. vols. 1-4, 6-15, 1880-1883, 1885-1894. *Hartford, 1880-1883, 1885-1894.* Gift of F. A. Halsey.

MARINE STEAM TURBINES, G. Bauer and O. Lasche. Translated from the German and edited by M. G. S. Swallow. *New York, 1911.*

DIE MASCHINEN-ELEMENTE, M. Schneider. 2 vols. *Braunschweig, 1903.*

METALLOGRAPHIE. pts. 7-12. *Berlin, 1911-1912.*

MODERN GASOLINE AUTOMOBILE, ITS CONSTRUCTION, OPERATION, MAINTENANCE AND REPAIR, V. W. Page. *New York, 1913.*

NEW YORK CENTRAL AND HUDSON RIVER RAILROAD COMPANY WOOD BOILERS TEST No. 907. Report by J. W. Harkom. December, 1912. *Media, 1912.* Gift of W. H. Wood Loco Fire Box and Tube Plate Co.

NEW YORK STATE COLLEGE OF FORESTRY AT SYRACUSE UNIVERSITY. How to increase the Durability of Fence Posts, Shingles and other Farm Timbers. *Syracuse, 1912.* Gift of college.

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THE PITOT TUBE APPLIED TO THE MEASUREMENT OF AIR, L. Loeb. Reprinted from Journal of the American Society of Naval Engineers, November, 1912. Gift of author.

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PROGRESS OF WARSHIP ENGINEERING. By C. de Grave Sells. n.p. n.d. Gift of author.

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REPORT ON DEVELOPMENT OF TRANSIT SYSTEM. pt. 1, Transportation Facilities for Panama-Pacific Exposition at Harbor View to the Board of Supervisors City of San Francisco, B. J. Arnold. Preliminary Report No. 10, December 2, 1912. Gift of author.

SHIPPING CASUALTIES. LOSS OF THE STEAMSHIP "TITANIC." Report of a formal investigation into the circumstances attending the foundering on 15th April, 1912, of the British Steamship "Titanic" of Liverpool, after striking ice in or near latitude 41° 46′ N., longitude 50° 14′ W., North Atlantic Ocean, whereby loss of life ensued. *London, 1912.* Gift of John R. Freeman.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION. Proceedings and Question Box, 7th Annual Convention, 1911. *Houston, 1911.* Gift of association.

STEAM ECONOMY IN THE SUGAR FACTORY, Karl Abraham. Translated by E. J. Bayle. *New York, J. Wiley & Sons, 1912.*

The translator is engineer of the American Beet Sugar Company. The author follows the various operations in a beet sugar factory, and works out formulæ for the heat losses. An unusual feature is the insertion between pages of the text of pages of cross-section paper.

REPORT ON TRAFFIC AND SERVICE IN THE DOWNTOWN DISTRICT TO THE BOARD OF SUPERVISORS CITY OF SAN FRANCISCO. Preliminary Report No. 11, December 23, 1912, B. J. Arnold. Gift of author.

STEAM ENGINE AND GAS AND OIL ENGINES, John Perry. *London, 1909.*

TRAVELING ENGINEERS' ASSOCIATION. Proceedings 20th Annual Convention. *Buffalo, 1912.* Gift of association.

UNA-FLOW STEAM ENGINE, J. Stumpf. *Munich, 1912.* Gift of Ed. H. Trump.

The straight-flow steam engine may be said to have passed the experimental stage (there are now working or in actual construction engines with an aggregate output of more than 500,000 h.p.) and a book on its principles and construction in English is certainly in order, particularly when written by a man as eminently qualified to speak on this subject as the inventor himself. The purpose of the straight-flow engine is to do in one cylinder what is usually done in several. To do this, the working steam is allowed to enter from below into the hollow cover, where it heats the surfaces of the cover and then passes by a valve in the upper part of the cover into the cylinder; it then follows the piston while giving up its energy and after it has expanded, passes out at the end of the piston stroke through the exhaust ports arranged in the middle of the cylinder and controlled by the piston. By eliminating all cooling of the clearance surfaces by the exhaust steam an effect is obtained somewhat similar to that usually produced by superheating, while the use of a ring of exhaust ports or slots in the cylinder enables the area of the exhaust passage to be made three times as great as the port area obtained by the use of slide or other valves. The result of this large exhaust area is that the end pressure in the cylinder is that of the condenser, especially when the use of long and narrow pipe connections between the condenser and the cylinder is avoided. The peculiar characteristic of the straight-flow steam engine is that, as a single cylinder engine, it works with saturated steam just as economically as with superheated. That does not mean, of course, that superheating the steam is of no value whatever. All along the way up to the admission valve the economy of superheating even in straight-flow engines is quite material, but once inside the cylinder, dry saturated steam gives as good results economically as superheated, owing to economy in lubrication. Superheats far higher than usual may be used in the straight-flow engine, because the last part of the expansion line falls, even with the highest initial temperatures, below the saturation line, and even with a hot steam jacket on the cover, practicable working temperatures are obtained for the cylinder and cover. All this makes it worth while for the American steam engineer to gain a closer acquaintance with this type of engine, which is less known in this country than it deserves to be. The book is well written and edited. The selection of the term "Una-flow" is unfortunate; "uni-flow" or "straight-flow" are better known and have a more English sound.

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UNITED ENGINEERING SOCIETY

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Iowa Board of Railroad Commissioners, 34th Annual Report, 1911. *Des Moines, 1912.* Gift of American Electric Railway Association.

Kansas Gas, Water, Electric Light and Street Railway Association. Official Convention Proceedings, 15th Annual Meeting. *Kansas, 1912.* Gift of association.

Map of the Island of Porto Rico, showing Macadamized Roads, Railroads and General Topography. Gift of the Photoprint Co.

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Universal English-German and German-English Dictionary. Felix Flügel, pt. 2. *Braunschweig, 1912.*

Gift of J. W. Lieb, Jr.

Bollettino dell Associazione fra gli Ex-Allievi del Politecnico Milanese fondata nel 1902. Vol. 1-3, 1865-1909. *Milano, 1904, 1907, 1910.*

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———Brussels, 1906. 65 pamphlets.

Gift of Wm. Paul Gerhard

The Society wishes to thank Dr. Wm. Paul Gerhard for a large number of interesting books and pamphlets which he has placed at the disposal of the United Engineering Society Library.

EXCHANGES

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Johns-Mansville Co., *New York.* J-M Power Expert, December 1912.

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Under-Feed Stoker Co., *Chicago, Ill.* Publicity Magazine, December 1912.

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Columbia University	Nov. 9, 1909	Chas. E. Lucke	E. M. Stone	E. A. Jareckie
Cornell University	Dec. 4, 1908	R. C. Carpenter	S. D. Mills	D. S. Wegg, Jr.
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LelandStanfordJr.Univ.	Mar. 9, 1909	W. F. Durand	A. Sanborn	C. T. Keefer
Mass. Inst. of Tech.	Nov. 9, 1909	E. F. Miller	J. G. Russell	J. B. Farwell
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Ohio State University	Jan.10, 1911	Wm. T. Magruder	R. H. Neilan	R. M. Powell
Penna. State College	Nov. 9, 1909	J. P. Jackson	J. F. Blank	G. W. Barger
Purdue University	Mar. 9, 1909	G. A. Young	A. W. Kimmel	G. F. Lynde
Rensselaer Poly. Inst.	Dec. 9, 1910	A. M. Greene, Jr.	E. Kneass	R. F. Fox
State Univ. of Ky.	Jan.10, 1911	F. P. Anderson	R. R. Taliaferro	F. J. Forsyth
Stevens Inst. of Tech.	Dec. 4, 1908	Alex.C. Humphreys	J. H. Vander Veer	J. Strauss
Syracuse University	Dec. 3, 1912	W. E. Ninde	O. W. Sanderson	R. A. Sherwood
Univ. of Arkansas	Apr.12, 1910	B. N. Wilson	M. McGill	C. Bethel
Univ. of California	Feb.13, 1912	Joseph N. Le Conte	J. F. Ball	G. H. Hagar
Univ. of Cincinnati	Nov. 9, 1909	J. T. Faig	C. W. Lytle	A. O. Hurxthal
Univ. of Illinois	Nov. 9, 1909	W. F. M. Goss	C. A. Schoessel	E. M. McCormick
University of Kansas	Mar. 9, 1909	F. W. Sibley	E. A. VanHouten	L. E. Knerr
Univ. of Maine	Feb. 8, 1910	Arthur C. Jewett	E. H. Bigelow	O. H. Davis
Univ. of Missouri	Dec. 7, 1909	H. Wade Hibbard	F. I. Kemp	R. Runge
Univ. of Nebraska	Dec. 7, 1909	J. D. Hoffman	P. S. Toney	M. C. Evans
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Washington University	Mar.10,1911	E. L. Ohle	D. Southerland	A. Schleiffarth
Yale University	Oct.11, 1910	L. P. Breckenridge	C. E. Booth	O. D. Covell